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CIRCLE 38 ON FREE INFORMATION CARD

Radio-Electronics

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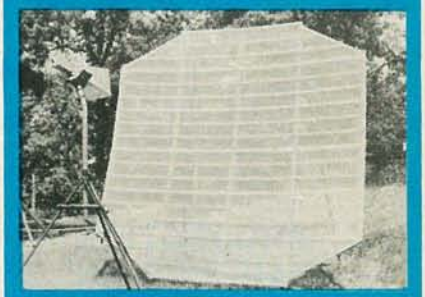
AUGUST 1981 Vol. 52 No. 8

ON THE COVER

The first integrated circuit made its appearance 20 years ago. It held four transistors. Today, devices containing well over 50,000 transistors are available and IC's with several hundred thousand transistors on a single silicon chip are in the planning stage. Learn where we've been and where we're headed. The story starts on page 41.



ALTHOUGH PRICES are slowing coming down, satellite TV antennas still represent a substantial investment. You can build the 8-Ball for under $750, using readily available materials. Plans for this antenna begin on page 45.

DIGITAL AUDIO RECORDING is now available to anyone owning a VCR. Turn to page 67 for a detailed explanation of the method involved and the standards that have been established for this technique.

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looking ahead

BETA'S COMEBACK

It's no secret that the Beta home VCR format has been taking a clobbering from VHS at the marketplace. A slight Beta comeback began in late 1980, and now a new series of recorders may lead to a more complete reversal of the situation. Sony has redesigned its recorders from the ground up—changing, miniaturizing, and producing a complete new look that truly capitalizes on the smaller size of the Beta cassette.

The first of the new Beta's is the new 9½-pound portable described here last month, to be introduced in the U.S. by both Sony and Zenith. The second, containing many of the features of the portable, is a new AC home unit that is just over three inches high and has the appearance of a fine hi-fi component. The old cassette-loading elevator has been replaced by a slot in the front, and the complex series of belt drives by six tiny motors. The reel-drive motor is so small that it fits into the spindle. The home unit, less than half the size of its predecessor, is programmable for two weeks (four channel changes) and contains a wide variety of special effects, with all functions controlled by an infrared wireless remote unit.

One of the unit's striking features is a multi-purpose fluorescent display panel, that shows the time when the unit is turned off. When it's turned on, it replaces the traditional tape counter with a display showing elapsed playing time in minutes and seconds, activated by counting sync pulses electronically. The panel is also used for setting the automatic programmer, cuing the user through the step-by-step setup process. One of the recorder's soft-touch electronically activated pushbuttons can put up to nine index pulses on the tape for instant program-segment locations—and those indexing pulses are indicated on the display. A separate multi-LED display indicates tape remaining in the cassette. By fall, Sony and Zenith are expected to offer as many as five different VCR's using the new Beta design—which, of course, is compatible with other Beta recorders. It will record in Beta II or Beta III speeds and play back in those or Beta I.

PROJECTION MARCHES ON

Giant-screen TV is moving ahead with two unique rear-projection designs. The most unusual is a new set by Zenith. When turned off, it looks like a furniture cabinet about the size of a lowboy 25-inch console. When the "on" button is pressed on the infra-red wireless remote control, the top of the cabinet hinges back and a 45-inch lenticular screen rises slowly upwards. When you're finishing viewing, just click the remote off and the screen descends back into the console.

The unit uses three 5-inch projection tubes made by Zenith, with faceplates angled so that the picture is self-converging. The tubes' spot size is claimed to be the smallest in the industry and peak brightness is said to be 180 foot-lamberts.

Another advanced rear-screen projector design will be fielded this fall by Magnavox, Philco, and Sylvania, all subsidiaries of North American Philips. The cabinet is far bigger than Zenith's and the picture measures 50 inches. The entire system—electronics, tubes, and optics—has been designed from the ground up for projection. The most striking aspect of this set is its special fresnel screen. It incorporates 1000 lenticular lenses surrounded by a black matrix, similar to that used in picture tubes, to increase contrast. The enhanced contrast results in a picture with quality close to that of a direct-view tube. The manufacturer claims that the system presents 410 lines of resolution from direct video input (330 from an off-air picture), with a 40 to 1 contrast ratio in 50-foot-candle ambient light, and a wide viewing angle.

Both the Zenith and the Philips projectors, priced at $3,500 and $3,750 respectively, use f/1 lenses built by U.S. Precision Lens Co. A new extremely compact lens system, designed for rear-projection, currently in the works, is expected to give birth to the next generation of small-cabinet sets next year. This new system, combined with such approaches as Zenith's pop-up, should lead to new popularity for projection sets.

CATALOG ON DISC

Many—but not quite all—of the traditional functions of the Sears catalog may be taken over by the videodisc. As an experiment, Sears is distributing the electronic version of its 236-page summer catalog to 1000 owners of Pioneer LaserDisc players. The optical disc is divided into 13 "merchandise shops," directly addressable by frame number, and 13 "fashion shows and demonstrations," which may be called up by dialing the proper chapter number. The latter consist of demonstrations in motion and sound, the former of still frames illustrating and describing the merchandise. There are nearly 18,000 items on the single-sided disc, which would run only 28 minutes if played straight through. In addition to copies at the homes of player owners, Sears will have the disc catalog available at some catalog order stores and counters. Interestingly, although Sears uses the optical system for its catalog, it is selling only the CED capacitance-type disc player for consumer use.

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

"No one else gives you as many functions in a handheld DMM.

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We've got great news for people who've been holding out for a high quality, high performance DMM at a moderate price: Fluke's new nine-function model D 804 is now available at select electronics supply stores.

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what's news

Specialists in demand by employers in '80's

Graduate computer scientists will be recruited by more firms than graduates in any other specialty, according to a recent survey of 947 employers hiring technical graduates in 1981. Mechanical and electrical engineers are also in demand and will be recruited by two-thirds of the companies surveyed.

The demand for new specialties will be increased by the new technologies now developing. The survey source, Peterson's Guides Annual Survey of Technical Career Opportunities, lists 100 companies that are seeking nuclear engineers, 27 that are hiring meteorologists, 40 that are recruiting marine engineers, and 21 that need solar engineers.

Digital radio broadcasts

In a U.S. radio "first", San Francisco station KQED-FM has aired a series of concerts recorded live using digital audio. The complete season of the San Francisco opera, as well as concerts of other San Francisco musical organizations, were included in the station's nationally broadcast programs. Station KQED is using a Sony *PCM-100* digital processor for the recording and broadcasts, which are beamed to 244 National Public Radio affiliates via the National Public Radio satellite.

The reaction of listeners and participating radio managements has been "extremely positive," says KQED. A typical comment is that the digital recordings are "identical" to a direct live audio pickup (unlike analog recording, which has inherent tape hiss and a much smaller dynamic range). The station's chief engineer says, "The PCM recordings sound exactly like live broadcasts. In A/B comparisons, I can't tell the difference."

The digital system has advantages other than fidelity. Tape and storage costs can be cut since the digital recordings are stored on videocassettes instead of reel-to-reel analog tape. The tapes suffer no detectable loss of quality with age and use, and they can be copied an unlimited number of times with perfect accuracy.

Electronics Hall-of-Fame Center proposed

Two vice presidents of the National Electronic Service Dealers Association (NESDA), Gene Dillingham and Bill Lawler, are leading a project to inaugurate a Hall-of-Fame Center as a tribute to those who have made significant contributions in the field of electronics. It would include for starters such figures as Thomas A. Edison, inventor of the electric light, motion pictures, and the phonograph; Lee deForest, the father of radio; Hugo Gernsback, publisher, inventor, and electronics prognosticator, and David Sarnoff, color-TV pioneer.

Dillingham and Lauder presented the plan to NESDA's House of Representatives, which approved the project January 31, 1981.

NESDA is inviting EIA, NEDA, ITA, NAEDA, NABER, NAVA, NATESA, and all other national associations in the electronics industry to join in making this Hall of Fame possible by forming a Hall-of-Fame Foundation to administer the operation of the Hall-of-Fame Center.

Inquiries may be sent to NESDA, Attention: J. W. Williams, 2708 West Berry St., Fort Worth, TX 76109.

KQED'S CHIEF ENGINEER FRED KROCK and music director Victor Ledin with Sony's *PCM-100* digital audio encoder.

New small-car wiring system

A novel prototype car "wiring" system was displayed by National Semiconductor at the recent Society of Automotive Engineers conference and exhibition. It was designed to solve the problem of space limitation in today's small cars.

The steady stream of compact economy cars has posed a multitude of problems for engineers. In particular, the space available for automobile electrical harnesses—bundles of electrical wiring throughout the car—has been restricted severely. The ever-increasing variety of electrical accessories on the newer cars makes the problem even worse.

National Semiconductor's system consists of transmitters, receivers, and a power conditioner. The transmitters are connected to the regular dashboard switches (ignition, lights, etc.) They send an encoded signal when the switch is turned "on" (closed) and another when it is opened. The receivers decode the signals and turn on the corresponding loads (headlights, wipers, etc.) or turn them off, as instructed.

The system's power conditioner filters transients from the vehicle's electrical system, protecting transmitters and receivers and preventing false signals.

With this new multiplex "wiring" system, the wiring harness can be reduced to three wires: a high current-load power wire, a multiplex system power wire, and a ground wire. The space saving is significant. In addition, the new system permits adding extra electrical accessories at will, simply by connecting additional transmitters and receivers to the three key wires.

Speech synthesizer for low-volume users

The Votrax SC-01 speech-synthesizer IC is now available in low-volume quantities through the company's newly established sales division, Vodex, states Vodex general manager Russell Thielman. The SC-01 IC, released in 1980, is a speech-synthesizer IC that produces speech using a proprietary technique for combining electronically generated phonemes through a series of electronic commands to make an unlimited vocabulary.

The "talking" IC can now be purchased in quantities from five to 5,000, where, previously, it was available only for large-volume orders. In quantities of 1,000, the IC is available at a per unit cost of $37.50, says Thielman.

continued on page 12

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what's news

continued from page 6

Lithium photo batteries

A new high-performance cylindrical photographic battery with a storage (shelf) life of more than five years is now available. Introduced by Duracell International Inc., it is the first cylindrical lithium battery available for consumer use in this country.

DURACELL's *PX28L* LITHIUM BATTERY

The new 6-volt battery is made up of two 3-volt cells. It is directly interchangeable with present alkaline and silver-oxide types and fits a wide variety of 35-mm cameras.

Most photo batteries have a storage life of only one to two years, and many serious photographers change them oftener than once a year, to be sure of dependable service. The Duracell *PX28L* can be stored in a camera for more than five years with little or no loss of energy.

Telematic acquires RCA division

Telematic, a manufacturer of TV service components and an early constructor of test jigs and adapters, has acquired the RCA Test Jig and Adapter Division.

The company will manufacture the RCA test jig and adapters as an independent line. It will continue to make its own test jig and adapters. The combination will enable Telematic to service practically every television set in use today.

All products will be supplied from Telematic's plant at 108-02 Otis Avenue, Corona, NY 11368.

Hitachi wins lawsuit

Hitachi, Ltd., Tokyo, Japan, has announced that the billion-dollar antitrust and antidumping lawsuits filed by Zenith Radio Corp. and National Union Electric Corp., against 21 Japanese and U.S. companies, including Hitachi and two of its subsidiaries, have been dismissed by the U.S. District Court in Philadelphia. The complaints, filed in 1970 and 1974, alleged that the defendants and almost 100 alleged co-conspirators had conspired to take over the U.S. market for television receivers and other consumer electronic products by concerted dumping and price discrimination, and by pursuing unlawful acquisitions in the United States.

The decision by Judge Edward R. Becker, coming after more than ten years of litigation, granted Hitachi's motion for summary judgment as to all of plaintiffs' claims under the Sherman Act, Robinson-Patman Act, Clayton Act, and the 1916 Antidumping Act. Last year the Court granted Hitachi's motion for summary judgment as to all but minor aspects of plaintiffs' other claims under the 1916 Act. That ruling has been appealed and is pending before the U.S. Court of Appeals in Philadelphia.

Local TV stations may triple in three years

If positive action is taken on rule-making procedures now before the FCC, the number of channels available to the TV viewer in most areas will increase within three years to at least three times the number now available.

That statement was made by *Lo-Power Digest,* a new publication aimed at entrepreneurs who may be interested in the proposed new field for investment. It is based on the FCC's decision to take applications for new low-power stations under the same rules as regular "translator" stations, that simply repeat the programs of present TV stations in areas where the coverage is not good.

The result has been a flood of applications—supposedly exceeding 1,000 per month—for the new stations. It is hoped that new highly stable low-power solid-state transmitters may allow the FCC to relax some of the rules now applicable to high-power stations to allow the low-power stations to operate at a lower cost than is now possible. That, plus low-cost cameras and video-tape systems, may make low-power local TV stations feasible in smaller cities that are not now considered large enough to support a local station.

"Low-power television broadcasting, the first new broadcast service considered by the FCC in 20 years, offers the same possibilities as the advent of commercial television broadcasting in the 1940's," says Charles D. Ferris, Chairman of the FCC. "It poses the exciting challenge to commercial and noncommercial entrepreneurs of creating programming to make the new service attractive to Americans."

The proposed new service would operate on UHF channels, with a power maximum of 1,000 watts—enough to cover almost any average-sized city. Stations would be licensed to drop in on nearly any channel where they could prove that no interference would be caused to existing stations.

FIRST CO_2 MILITARY LASER

HUGHES AIRCRAFT ENGINEER William Tomita adjusts the transmitter on an advanced prototype model of the first carbon-dioxide laser developed in the United States for tactical military applications. The transmitter and its electronics will be housed in the white casing at left. The new laser will have several key advantages over the solid-state lasers now used in military rangefinding. A carbon-dioxide laser will penetrate battlefield smoke and dust better than a solid-state device. It also operates in the same waveband as the tank's thermal-imaging system. That means that the laser will reach any target that the gunner can see through his thermal night sight. The new laser is harmless to the human eye and can be used safely in training exercises.

Direct satellite broadcast endorsed by FCC

At a recent meeting, the FCC endorsed the general idea of direct television broadcasting from satellites to private homes. It also took under consideration a COMSAT proposal to provide that service.

Few of the details of the proposed service were worked out, but the Commission expects to be able to give final approval to the new service sometime in 1981. The FCC has already warned microwave communications systems that they may have to cease operating in the 12-GHz band, because of possible interference with the satellite-home TV signals.

Television broadcasters are not happy with the new proposal; the National Association of Broadcasters suggests that the service should be studied further, and then approved by Congress before implementation. "Any interim approval by the FCC is shortsighted," stated NAB president Vincent T. Wasilewski. **R-E**

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2. Peripherals

These include the popular *Heath/Zenith 19 Smart Video Terminal,* loaded with professional features. And the *14 Line Printer,* priced as low as $495. Other printer brands are on display, including high-speed, typewriter-quality printers.

3. Software

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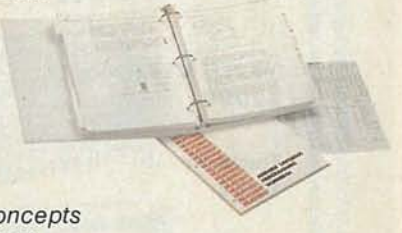
8. Self-Study Courses



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editorial

Becoming An Author

Wherever I go, the most often asked question is: "How do I go about writing an article for **Radio-Electronics**?" I do not dismiss that question lightly. Our readers represent a vast untapped reservoir of knowledge. Each and every one of you has developed a special expertise in at least one particular area. Many of you have unique ideas and knowledge that is not widely known. The drive to acquire knowledge and share knowledge and ideas with others is immense. In fact, that is the main function of **Radio-Electronics**. It is a vehicle for the exchange of knowledge and ideas. For those reasons we encourage our readers to write articles.

What do you get out of writing an article? Aside from the extra income and recognition of having your name in print, there's the satisfaction of sharing your knowledge with others. In effect, you have advanced the knowledge of the members of this industry and have helped people just like yourself. Indeed, it is a rewarding and satisfying achievement.

Submitting an article is not difficult. It is simply a matter of sending it to my attention. The best first step, however, is to send me an outline of the article to see if we're interested in the subject. If we are, we'll tell you to go ahead and perhaps even make a few suggestions regarding your outline.

There are far too many steps involved in writing an article for us to cover here. However, we do have an Author's Guide that will answer many of your questions. If we've managed to stir your curiosity, then send a self-addressed stamped envelope to Author's Guide, **Radio-Electronics,** 200 Park Avenue South, New York, NY 10003, and we'll send you one.

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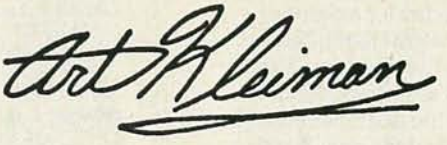

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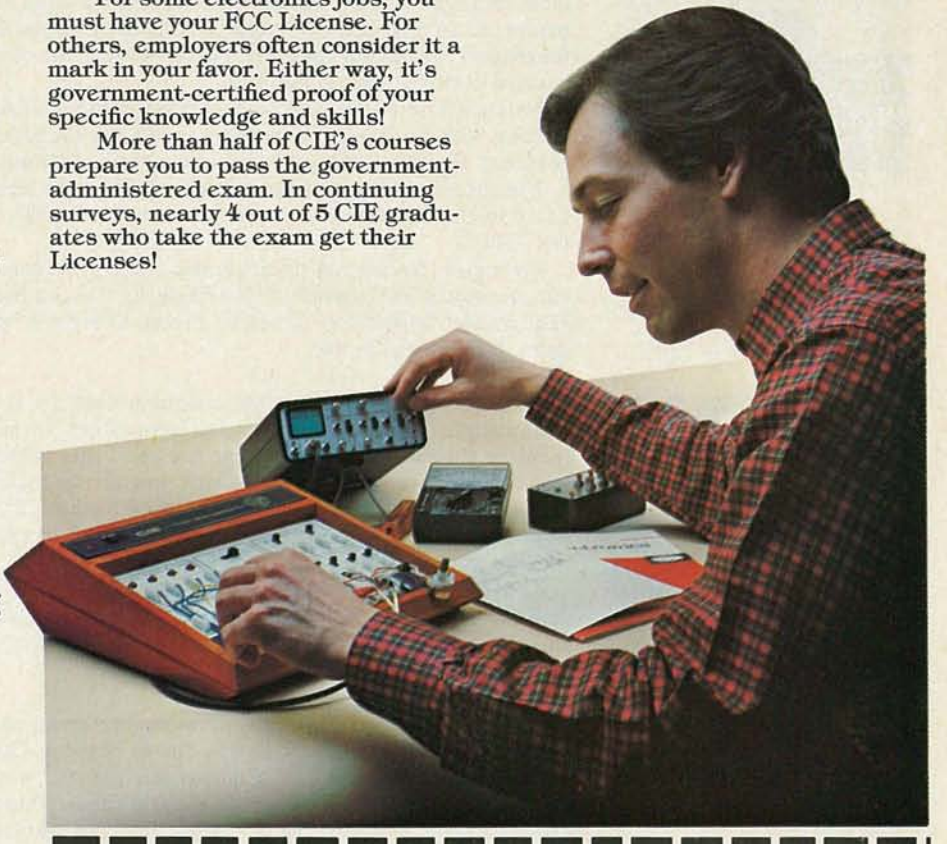

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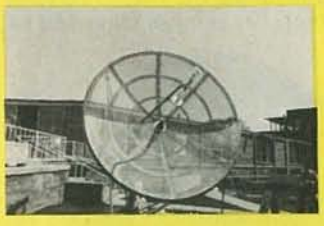


At the latest gathering of the Satellite Private Terminal Seminar in Washington in early spring, the cost of home satellite receivers dropped to an all-time low. Complete packages of equipment were available for as little as $1,800. In truth, a realistic package of antenna, tuner, LNA, and associated hardware still costs around $3,000 for a parabolic dish; and that means a retail price of up to $6,500 for the same equipment. But if you'll be satisfied with a spherical antenna and lesser quality hardware, you can get into satellite TV for under $2,000.

Close to 2000 people showed up for the SPTS conference and there were more than 50 exhibits. Even Ralph Nader stopped by to offer a word of encouragement. A number of new vendors showed up with equipment, such as SatFinder Systems, which unveiled several equipment packages. Its SS-1 deluxe rotatable antenna setup includes a 10-foot fiberglass dish, a polar mount, LNA and polarity motor, additional equipment, and directions on how to install a foundation, forms, and assembly. For $1700 less, the company offers a hand-rotatable unit with a scaled down equipment package.

National Microtech came with a glossy package of literature and a full-line of equipment, starting with its Apollo XK package for $3,980 (including 120° LNA, 10-foot dish and KLM receiver). Remote tunable receivers were available from many new suppliers.

The success of the conference bodes well for the next SPTS conference slated for August 14-16 in Omaha. Details are available from Satellite TV Technology Inc., PO Box G, Arcadia, OK 73007.

Among the fascinating visual glimpses during the conference were the array of dishes spread out all around the grounds and parking lots of the hotel where the meeting was held. The exhibits even lapped over to nearby streets, where one vendor parked his car, with a trailer and small-dish antenna in tow.

DISHES AT BROADCASTERS CONVENTION

The increasing interest in satellite communications by major TV broadcasters was evident at the National Association of Broadcasters convention. In much the same way that the cable TV industry plowed into satellite usage five years ago, broadcast operators now seem ready to get into the act effectively. AT&T, which now carries much of the network TV broadcasting via microwave circuits nationwide, was on hand to show off several of its new services for satellite transmission—including an impressive all-digital process that it can now use for FM radio satellite transmission.

As at other conferences, the parking lot was packed with dishes, including a novel "SimulSat" dish that was unveiled by Satellite Communications Network, a small New Jersey firm. The antenna, which looks like a cut-off version of a 10-meter dish, can pick up signals simultaneously from as many as four different satellites.

NETWORKS GOING ALOFT

The ABC, CBS, and NBC TV networks are going to test the idea of sending all of their programming via satellite. The test, due to begin in October, will last about three years and probably use the latest AT&T Comstar satellite (87° west longitude). One network official said the networks expect to know within a year if the satellite feed is preferable to the expensive and extensive set-up of terrestrial microwave facilities that the networks now use.

AT&T may have another interesting new customer—the world's largest printer, R. R. Donnelley and Sons. The company wants to transmit high-speed data—1.5 million bits per second—to its regional printing plants. It would be the first commercial use of AT&T's satellites for such massive data transmission.

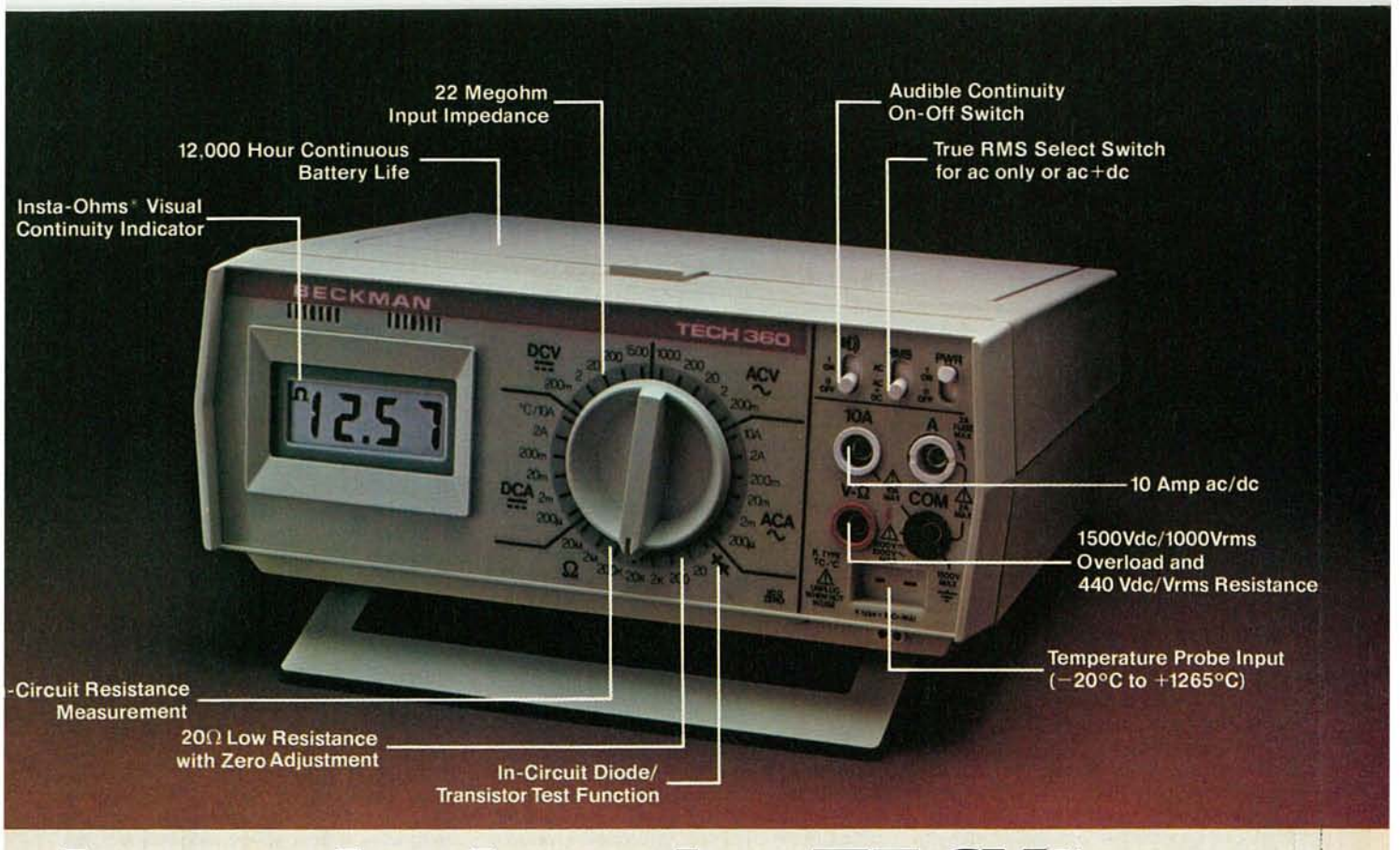
AROUND THE SATELLITE CIRCUIT

RCA Americom has developed a new satellite TV distribution technique that makes it possible to put earth stations in areas subject to terrestrial microwave interference. Optimized Video Transmission (OVT) is a method that makes it possible for a TVRO to be co-located with TV studios in electronically congested downtown areas. The new technology can produce a substantial improvement in the picture by eliminating the low-level impulse noise that is often prevalent in small earth stations; in essence, the system shaves off part of the bandwidth to eliminate interference from other RF transmissions.

Wold Communications, which is offering expanded video programming for broadcast and private TV networks, will begin using two transponders on the new AT&T satellite, probably beginning around next March 1.

Satellite Music Network is now beaming two audio channels—Modern Country music and Pop Adult music—via Westar to radio stations around the country.

GARY ARLEN
CONTRIBUTING EDITOR



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letters

NATIONAL IC's

I have good news for readers who have had trouble locating the National IC's used in my recent projects. The National MM 5369EST/N is available for $2.85 postpaid, and the 74C90N is available for $1.82 postpaid. Both IC's may be ordered from Circuit Specialists Co., PO Box 3047, Scottsdale, AZ 85257—and *for these parts only* there is no minimum order.

They also have other hard-to-find parts.
GARY McCLELLAN

LED VU METER

We noticed Brad Albing's article, "Led VU Meter for Your Hi-Fi," in the May **Radio-Electronics.** It was good, but he is quite out of date in saying that "at the present time, only Exar is manufacturing an IC suitable for use in a VU meter." National Semiconductor has been making the LM3916 for over a year now, and it covers the VU range from +3VU to −20VU. This IC includes complete output-current drivers for LED's so that no external transistors or current-limiting resistors are needed. Also, when used in conjunction with an LM3915, it can cover a wider range to −40VU per the application notes in the LM3916 data sheet.
ROBERT A. PEASE,
Staff Scientist,
National Semiconductor Corporation
Santa Clara, CA

You're absolutely correct. However, Mr. Albing is not at fault. When he wrote the article, well over a year ago, the statement was correct. Our editorial staff must accept the responsibility for not catching this when we published the article.—Editor

BALLY ARCADE INFORMATION

I noticed Mr. Cornett's letter on page 23 of the May issue of **Radio-Electronics.** One would infer from it that there was no other Bally-oriented information source available. In actuality, I have been publishing the *Arcadian* Newsletter since November, 1978.

I realize that this is a pure oversight on Mr. Cornett's part, since he has been a subscriber for quite a while, and it was his advertisement in issue number 11 that started his current operation.

I would appreciate a mention of the *Arcadian* in the next available issue of **Radio-Electronics,** to inform your readers of an alternative or concurrent information/software/hardware source. Our subscription rate is $12.50 per year.
ROBERT FABRIS,
Arcadian, 3626 Morrie Drive,
San Jose, CA 95127

PIRATE BROADCAST STATIONS

I am shocked and disgusted with the article, "Pirate Broadcast Stations" (**Radio-Electronics,** May 1981), wherein the author, Robert Grove, not only reports their existence but makes the article a plug for them. As I see it, a reputable magazine is now advocating breaking the law.

The article clearly shows the current leftist rhetoric against the "establishment," "thumbing their noses at the FCC," etc. I do not go along with the

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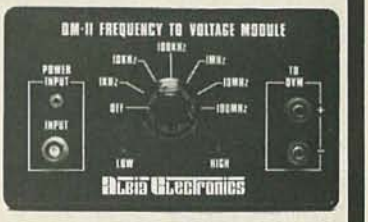

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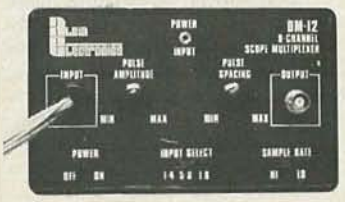

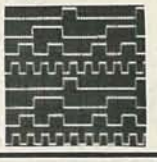

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CIRCLE 32 ON FREE INFORMATION CARD

proposition that the establishment is totally wrong in all that it does; that the FCC is guilty of "censorship," or that the outlaws provide "a breath of air" in a sea of drivel.

The next time you are over the ocean in a jet, let us hope that this "drivel" (your pilot calling traffic control, for example) is not drowned out by some illegal nitwit who is selfishly using something that is not his to use.

Let us give credit where credit is due. I have been in radio communications for nearly half a century; I have always found the FCC to be honest, fair, and conscientious. I have worked in practically all types of radio, and I have always felt that 99% of my fellow workers in the industry have bent over backward to obey the rules; that without such voluntary cooperation, of course, the FCC would be powerless, and the airwaves would be a nightmarish mess. (Take a look at the citizens-band mess.) I also feel that the legal amateurs have earned their right to a portion of the spectrum, and resent being crowded out by the outlaws.

Finally, radio is international. Granted, the agreements are not perfect; but they are a reminder that the nations can and do get together in some things of mutual benefit (such as the postal service, World Health Organization, etc.). How an American magazine could run an article that condones these frequency thieves is beyond my comprehension.

BEN LANE,
Tolovana Park, OR

AUDIO POWER METER

In reference to the article, "Audio Power Meter" in the February 1980 **Radio-Electronics**: there's an error on page 46 in the component-placement guide: D7 (diode D7) is placed backwards. The schematic on pages 44/45 is correct.

After many frustrating hours, where my right channel wasn't operating, while the left channel worked perfectly, I found that the above was the solution. Other than that, I'm very happy with the meter.
DAVE KRABBENHOTT

CABLE TV

Recently, I read your editorial, "Cable Television—The Cloud Behind the Silver Lining" (**Radio-Electronics,** February 1981), and I am very disturbed by what I have been reading in your magazine, and elsewhere, with respect to the future of broadcast television and cablevision.

I, for one, do not wish to see cable compete with the networks or local stations if commercials are going to dominate the cable-TV networks the way they have on broadcast television.

I do not mind paying for cable-TV if I can watch a program without the loud and annoying commercials, watch programs that are slanted towards the consumer (auto repair, food-purchasing, etc.), watch recent *quality* movies (regardless of movie ratings), and enjoy a multitude of cable's exclusive services, such as the interactive systems. In the near future, those interactive systems will allow a home to be wired via the cable company for intrusion alarms, allow the elderly to call for emergency aid, and provide other services requiring two-way communications.

The interactive systems might be expanded to allow for a variety of discussion shows presenting information and answering questions via cable, or a toll-free telephone number, on a number of subjects such as satellite TV, amateur radio, minor television repairs, bicycle repairs, automobile maintenance and repair, cooking, cabinet-making—the list could go on and on.

There are just too many "time-fillers" on broadcast television, and not enough quality programming like *Perry Mason* or *Bonanza*, where the family can learn tidbits about law or obtain new viewpoints on the fair way to treat people. "How to" programs could help the consumer—even the most inept homeowner—to fight back at inflation. This, then, is the big challenge I see for cable-TV: to put "learning" back into television and take out the wasteful time-fillers. To add more commercials, or more shows like *Dukes of Hazzard*, is not a "service" to the public but a disservice. To pay for that kind of nonsense is just like rubbing salt into an open wound, and is an injustice to us all.

In summary, I don't mind paying for a service (something that offers potential benefit to us all), but I do mind, and object to, *paying* for more commercials and lower-grade programming that only allows us to waste away in our easy chairs in front of the idiot box.
KENNETH PROCTOR, E.E.,
Bricktown, NJ

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Non-Linear Systems Touch Test 20 DMM

CIRCLE 101 ON FREE INFORMATION CARD

THE *TOUCH TEST 20*, RECENTLY INTRODUCED BY Non-Linear Systems, Inc. (533 Stevens Ave., Solana Beach, CA 92705), is one of the most versatile digital multimeters on the market today. Using state-of-the-art technology, this unit offers ranges, functions, and features that would never have been found in such a compact instrument just a few years ago.

But state-of-the-art technology is wasted unless the unit is well-designed, accurate, and easy to use. I am happy to report that the technology in the Touch Test 20 is anything but wasted. Although the range-changing scheme is a little unusual, the Touch Test 20 does well on all counts and looks to be a winner.

In addition to having the usual voltage, current, and resistance capabilities, the *Touch Test 20* will also measure temperature (Fahrenheit from −40° to 302° and Celsius from −40° to 150°), capacitance, and conductance. The unit also features diode and continuity tests (using an audible signal). All ranges and functions are selected by small, front-panel mounted "touch-buttons." Red LED's above each function button tell you which function is in use. When you switch functions, an audible signal confirms that change.

Ranges are changed using the three "decimal point" buttons located immediately below the 3½-digit, LED display. Touching one of those buttons repositions the decimal point on the display so that it's located above the button used. Although it's easy to use, this scheme is somewhat different than the range-changing schemes found on most DMM's, so it's a good idea to read the instructions carefully before using the unit.

When the *Touch Test 20* is turned on, it automatically switches to the DC-VOLTAGE function and the 1000-volt range. DC voltages from 10 microvolts to 1000 volts can be measured over six ranges. An accuracy of ±0.2% is claimed by the manufacturer. The input impedance is 10 megohms and the A/D converter uses an integrating technique that offers high noise-rejection and good stability, with a minimum of critical components. AC-voltage from 10 microvolts to 750 volts (RMS) is measured over six ranges. Accuracy is ±0.5% using an average-responding converter. The input impedance is again 10 megohms. AC-current from 10 microvolts to 10 amps is measured over four ranges. DC-current from 0.01 microamp to 10 amps is measured over seven ranges.

Resistance is measured over seven ranges. Accuracy of the readings is said to be ±0.25%. In all but the highest range (20 megohms) the test voltage is less than 0.2 volt. That allows in-circuit tests to be made without "turning on" semiconductor devices. The *Touch Test 20* has a special DIODE TEST function that reads the forward voltage drop across the diode. Another useful function is the continuity test. In this mode, the *Touch Test 20* emits an audi-

ble tone that varies in proportion to the resistance measured.

The *Touch Test 20* can also be used to measure capacitance. It does so for capacitances from 1 picofarad to 200 microfarads over three ranges. The listed accuracy is ±1%. When the *Touch Test 20* was used to measure a lab-calibrated, 0.334 microfarad capacitor, the unit measured it as 0.333 microfarads. A component-test adaptor is provided which simplifies the connection of capacitors, resistors, and other devices to the front-panel jacks.

For those who need to make conductance measurements, the *Touch Test 20* will do it for conductances from 0.01 nanosiemens to 199.9 nanosiemens. The listed accuracy is ±0.2%. This feature is useful when testing insulation or in any situation where extremely high resistances are involved.

The *Touch Test 20* is neatly packaged in a 2.9×6.4×7.5-inch case. The unit weighs less than three pounds and is powered by a charger-type unit (supplied) for fixed operation or by three, "D-type", lead-acid cells for portable operation (a line-operation-only model is also available). The lead-acid cells will operate the unit for up to six hours. The cells take 16 hours to recharge.

The instruction manual is quite complete and covers theory of operation, service, calibration, and other technical topics. There is a full schematic and several pages of interior photos to aid in parts identification. The unit is covered by a one-year limited warranty.

The *Touch Test 20* is a pleasure to use and you have to try it to appreciate it. The *Touch Test 20* has a suggested retail price of $467.00 with the lead-acid cells, $435.00 without. **R-E**

continued on page 30

EQUIPMENT REPORTS

continued from page 29

BBC-Metrawatt-Goerz Model MA1H VOM

CIRCLE 102 ON FREE INFORMATION CARD

THERE'S A NEW ENTRY INTO THE FIELD OF measuring equipment, the BBC-Metrawatt-Goerz *model MA1H* analog VOM. The *model MA1H* is small, but quite versatile. There are six AC-voltage ranges: 1.5 to 500 volts (full scale). The nine DC-voltage ranges, 150 millivolts to 1000 volts (full scale) are selected by the front-panel selector-switch (as are all of the meter's ranges), but the zero–1000-volt range (DC) uses a separate input jack. Current (AC and DC) is measured over five ranges: 5 mA to 5 amps (full scale). An additional DC-current range of 0–50 *micro*amps (μA) can be selected by switching the meter to the 150-millivolt–50-microamp range. Because the meter needle's deflection is the same for those two ranges, the manufacturer decided to save a switch position by combining them. To get the proper reading, simply use the appropriate meter scale. All voltage and current ranges are calibrated in the 1.5–15–50 system, which simplifies making readings.

Resistance is read on four ranges; ×1, ×10, ×100, and ×1000. The ×1000 range can be used for checking semiconductors, since the current is limited to only 0.083 mA. The meter also has a DB scale, that measures from +5 to −15 dB. Zero dB is defined as 0.775 volts across 600 ohms. A calibrating chart is included in the instruction manual, with instructions for converting readings to dB, and the multiplier factor used.

All ranges are selected by a single switch in the center of the panel. The meter scale is larger than average and the markings are very clear and easy to read.

The instruction manual gives instructions and a calibration chart for rough-checking capacitors. We tried it out on a couple of filter capacitors, including one known to have a bad section. It read the values of the good sections quite accurately, and caught the open one.

The manual is written in three languages: English, French, and German. All functions are covered, plus instructions for servicing and recalibration if needed. The only thing missing from the manual (that I noticed) was a statement of the unit's accuracy. Using a 0.1% (full scale) voltmeter as a standard, I did some quick tests and found that the *model MA1H's* accuracy (at least on the voltage ranges I checked) fell well within 0.1%. That's ample accuracy for practical service work.

Overall, it's a nice-looking instrument, and very easy to use. The meter scale and range- and function-selector-switch are on the front panel; the test leads plug into jacks on the top of the case, which keeps them out of the way. Four jacks are used: COMMON, OHMS, VOLTS AND AMPS (AC/DC), and the 1,000-VOLT range. Those jacks are the recessed type, so no bare metal is exposed. The test-lead tips are novel and handy. They have very short, sharp tips, for probing closely-spaced points. Just above the tips is a set of springs allowing them to be plugged into any standard banana jack. A protective collar is built into the handle, to prevent accidental contact with potentially dangerous voltages and currents.

The model *MA1H* has a suggested list price of $74.00 for the meter and test leads. A carrying case is available for $22.00. From BBC-Metrawatt-Goerz, 165 Fieldcrest Ave, Raritan Center, Edison, NJ 08837. **R-E**

Heathkit Model IM-2400 Frequency Counter

CIRCLE 103 ON FREE INFORMATION CARD

EVER-RESPONSIVE TO THE NEEDS OF THE electronics industry, the Heath Company (Benton Harbor, MI 49022) has introduced a compact, hand-held frequency counter designed for portable use. The *model IM-2400* covers a frequency range of 50 Hz to 512 MHz and uses five rechargeable nickle-cadmium cells (included).

Published specifications include a typical sensitivity of 10 millivolts, with 25-millivolt sensitivity guaranteed throughout the range of the unit. Input impedance is claimed to be 1 megohm shunted by less than 20 picofarads in the 50-Hz–50-MHz range; 50 ohms in the 40–512-MHz range. Input protection is 150-volts RMS to 100 kHz, dropping to 10-volts RMS at 50 MHz. Input protection in the 40–512-MHz range is 5-volts RMS. The time base uses a 10-MHz master clock with a listed stability of ±1 part per million. Temperature stability is claimed to be ±10 parts per million from 0 through 40 degrees Centigrade.

Time bases of 1 or 0.1 second can be selected from the front panel. Resolution is determined by the range and time base chosen. With the RANGE switch in the 50-Hz–50-MHz position, and the TIME BASE switch in the 1-second posi-

tion, the resolution will be 10 Hz; with the TIME BASE switch in the 0.1-second position, the resolution will be 100 Hz. With the RANGE switch in the 40–512-MHz position, and the TIME BASE switch in the 1-second position, the resolution will be 100 Hz; with the TIME BASE switch in the 0.1-second position, the resolution will be 1 kHz.

The *model IM-2400* is, of course, a kit and, although I took great care in assembling the unit, I did have one serious problem; a solid short between two parallel traces on the printed-circuit board. When I could not find the source of the problem, I finally tried to eliminate it by gouging a deep channel in the board between the two shorted tracks. Doing that got rid of the problem and I can only guess that it was caused by a tiny bit of metal that was imbedded in the board itself.

Three methods of calibration are outlined in the instructions; using a standard communications or AM broadcast receiver, using another frequency counter and a signal generator, or using a laboratory-standard frequency generator. I used the second method and then checked the calibration against another frequency generator as well as a laboratory-standard generator. The results were well within the published specifications.

The quality of the service manual is always important, and, as usual, Heath has done an excellent job. Included with the manual is a large fold-out schematic and a complete technical description of the circuitry. All solid-state devices are listed with their circuit identification number, their Heath part number, and, where possible, substitutes. All pin-outs and transistor leads are clearly identified.

The *model IM-2400* measures 1⅝ × 3⅛ × 8⅛ inches. The display uses LED's that, though easy to read under any lighting conditions, consume quite a bit of current, making use of the optional battery eliminator/charger a good idea. An optional telescopic antenna with a BNC fitting (to match the one on the unit) is also available.

All-in-all, if you take your time building the *model IM-2400*, and treat it with any degree of care, it should perform well for many years. The *model IM-2400* sells for $144.95 ($190.00 assembled); the optional battery eliminator/charger sells for $4.95. **R-E**

IN A FIELD OF RAPIDLY CHANGING CONSUMER electronics, Radio Shack (1400 One Tandy Center, Fort Worth, TX 76102) stayed with their keyboard-entry programmable scanner, the *model PRO-2001*, an unusually long length of time. That scanner was a lead item in their catalog for many years. Now, a new top-of-the-line programmable scanner, the *model PRO-2002*, is dominating the Tandy line.

The new scanner is no miniature; it is virtually the same size as its predecessor. Frequency coverage is broader than some competitive units and includes the following ranges: 30–50, 108–136, 138–174, and 410–512 MHz. That means that the often-overlooked Federal government and military allocations in the 138–144 and 410–420 MHz segments of the spectrum are available to the listener.

Frequency steps for scanning and searching are at 5-kHz intervals on low and high band, 12.5-kHz intervals on UHF, and 25-kHz intervals in the AM aircraft band. There is no way to extend the unit's frequency limits, as is possible with some other scanners.

The *model PRO-2002* is a 50-channel microprocessor-controlled, frequency-synthesized programmable scanner. Frequencies entered are stored in five memory banks that can be called up in any combination. Scanning rate is selectable (six or three channels per second), as is search rate (eight or three steps per second). Another feature is the ability to store five separate search ranges, one in each of the five memory banks.

The scanning receiver uses either an integral whip antenna or an external antenna, connected using a rear-apron Motorola-type jack. Additional rear-apron connections include a TAPE-OUT jack for recording and an external-speaker jack. A two-pin recessed jack for DC is also available for mobile operation. The AC line-cord is permanently attached.

A 9-volt battery (not included) is used to retain the frequencies in memory when the AC line-voltage is interrupted. The battery is accessible from the back of the unit. The fluorescent display provides frequency, channel

number, delay, priority, channel and search bank, manual mode, program mode, search mode, and lockout symbols. The display is quite bright and easy to read.

The *model PRO-2002* contains an internal digital clock that displays hours, minutes, and seconds. A rear-apron slide switch allows the clock to be disconnected if desired during mobile operation to prevent battery drain when the vehicle is unattended for long periods of time.

A PRIORITY function may be used on any of the 50 channels; when activated, a signal appearing on the channel will automatically cause the scanner to lock on that channel until the signal is no longer present.

Search, lockout, and delay functions are conventional enough and work well. If an active frequency is found during the search function, pressing the MONITOR button will automatically insert that frequency into memory in place of the channel being displayed. If you attempt to program an out-of-range frequency, an error message will be displayed.

The Radio Shack *model PRO-2002* uses 1 LSI microprocessor, 1 LSI phase-locked loop, 9 CMOS integrated circuits, 13 additional IC's, 44 discrete transistors, and 75 diodes.

Sensitivity on the AM aircraft band is nominally 1.0 microvolt (10 dB signal-to-noise ratio at 60% modulation); low and high band FM sensitivity is 0.5 microvolt, and UHF sensitivity is 1.0 microvolt (20 dB signal-to-noise ratio at 3 kHz deviation).

Low and high band spurious-signal rejection (at band center) is 50 dB; UHF is not specified. UHF spurious signals (especially primary images) have been a common complaint among programmable scanner users. Sharp selectivity, is very difficult to achieve in low-cost consumer radios.

Selectivity is listed as ± 9 kHz at −6 dB and ± 15 kHz at −50 dB. Best IF rejection occurs at 154 MHz (−80 dB). An IF frequency of 10.7 MHz is normally found in all Radio Shack scanners.

The priority channel is sampled every three seconds, causing a 100-millisecond interruption of whatever scanner function happens to be in operation at the moment. Normally that's not a problem.

The DELAY function provides a 3-second hold on any channel searched or scanned that becomes active when checked. That allows reply time for the other units during two-way communications reception. Without the DELAY function, rescan or search will continue immediately after the carrier disappears.

The unit will accept all normal narrowband FM signals, ± 7 kHz. One crystal and one ceramic filter are used to tighten up the IF bandwidth; the second conversion frequency is 455 kHz. Squelch sensitivity is approximately 1 microvolt (signal plus noise-to-noise at 25 dB). Power consumption is nominal; 19 watts during AC operation and 10 watts during mobile use.

While the *model PRO-2002* is slightly more difficult to operate than some competitive units, the routine is easy to learn. An audio-tone generator beeps each time a program key is pressed, confirming that the command has been entered.

Another of the unit's features is the window detector; when the receiver stops on a search-discovered channel, it stops on the center frequency. That means that the frequency displayed will be accurate, even though there is a strong carrier.

We found the overall RF sensitivity to be quite good, nearly equal to a much higher-priced competitive scanner. It is certainly adequate for the majority of applications. Search-rate programmability and search-direction choice (up or down) are also advantages, adding to the flexibility of the unit. A CLEAR button allows the user to remove an accidentally-entered frequency.

All in all, we were pleased with the Radio Shack *model PRO-2002* scanning receiver. It sells for $399.95. **R-E**

IT SEEMS HARD TO BELIEVE THAT JUST a few years ago, the only economical means available to copy radioteletype was the teleprinter—a particularly cumbersome, noisy, mechanical behemoth.

Recent improvements in digital technology have now made possible a variety of attractive alternatives, not the least of which is the new

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CIRCLE 73 ON FREE INFORMATION CARD

Kantronics *Mini-Reader*.

Designed for reception flexibility, the *Mini-Reader* could well be the most versatile reader available to date. It is certainly the most compact reader available at this writing.

About the size of a standard calculator (5¾ × 3⅜ × 1¼ inches), the compact *Mini-Reader* features a bright, 10-character, fluorescent alphanumeric display. The characters displayed move from right to left, and the display is easy to read.

It compares very favorably with its predecessor, the *Field Day 2 SWL* model. And it's $150.00 cheaper!

Radioteletype (RTTY) messages are displayed at 60, 66, 75, and 100 words-per-minute. Since the internal active-filter monitors the "mark" signal only, "shift" is of no consequence. Normal or inverted mark/space is also of no importance.

On Morse reception, the *Mini-Reader* will track automatically at speed of 3-80 words-per-minute. Code practice with the little unit is a snap; simply insert a key into the appropriate jack and watch the display as you practice your keying. This will show up a sloppy fist every time. At the press of a button, the speed of the received Morse code can be displayed.

The *Mini-Reader* will also decode 100- or 300-baud ASCII. While the ASCII message is hard to follow at those speeds, the device can display individual characters to analyze data bursts.

When not being used to monitor the busy radio bands, the *Mini-Reader* can be used as a 24-hour clock, displaying hours, minutes, and seconds. The versatile little unit can also be used as a 24-hour timer. One unusual feature of the *Mini-Reader* is that it can be used as an audio-frequency counter, capable of reading from 0–79 kHz.

Our test

We plugged the *Mini-Reader* into the external-speaker jack of a popular general-coverage receiver so that we could see if the unit performed as claimed. Tuning in the familiar audio "diddly-diddly" of radioteletype, we adjusted the receiver tuning dial until the *Mini-Reader's* "ready" light blinked, indicating that we were centered in the audio passband. When the appropriate function key was pressed, the latest world news began to move across the display.

Next, we tuned in the CW portion of the 80-meter amateur band. Sure enough, the *Mini-Reader* worked perfectly. Admittedly, sloppy fists made some copy difficult, but even those could still be interpreted!

Perhaps most important of all, our general-coverage receiver could detect no RF interference from the unit. This was indeed a pleasant surprise. Even the earlier SWL model, though well-shielded, caused some interference at certain frequencies. The *Mini-Reader* was completely clean.

All in all we were very pleased with the *Mini-Reader*; it did everything that was asked of it, and more. Kantronics has done well in providing so much in such a small package.

The new Kantronics *Mini-Reader* is an important step forward in accessory technology. It lists for $314.95, and is available from your local Kantronics dealer. From Kantronics, 1201 E 23rd Street, Lawrence, KS 66044. **R-E**

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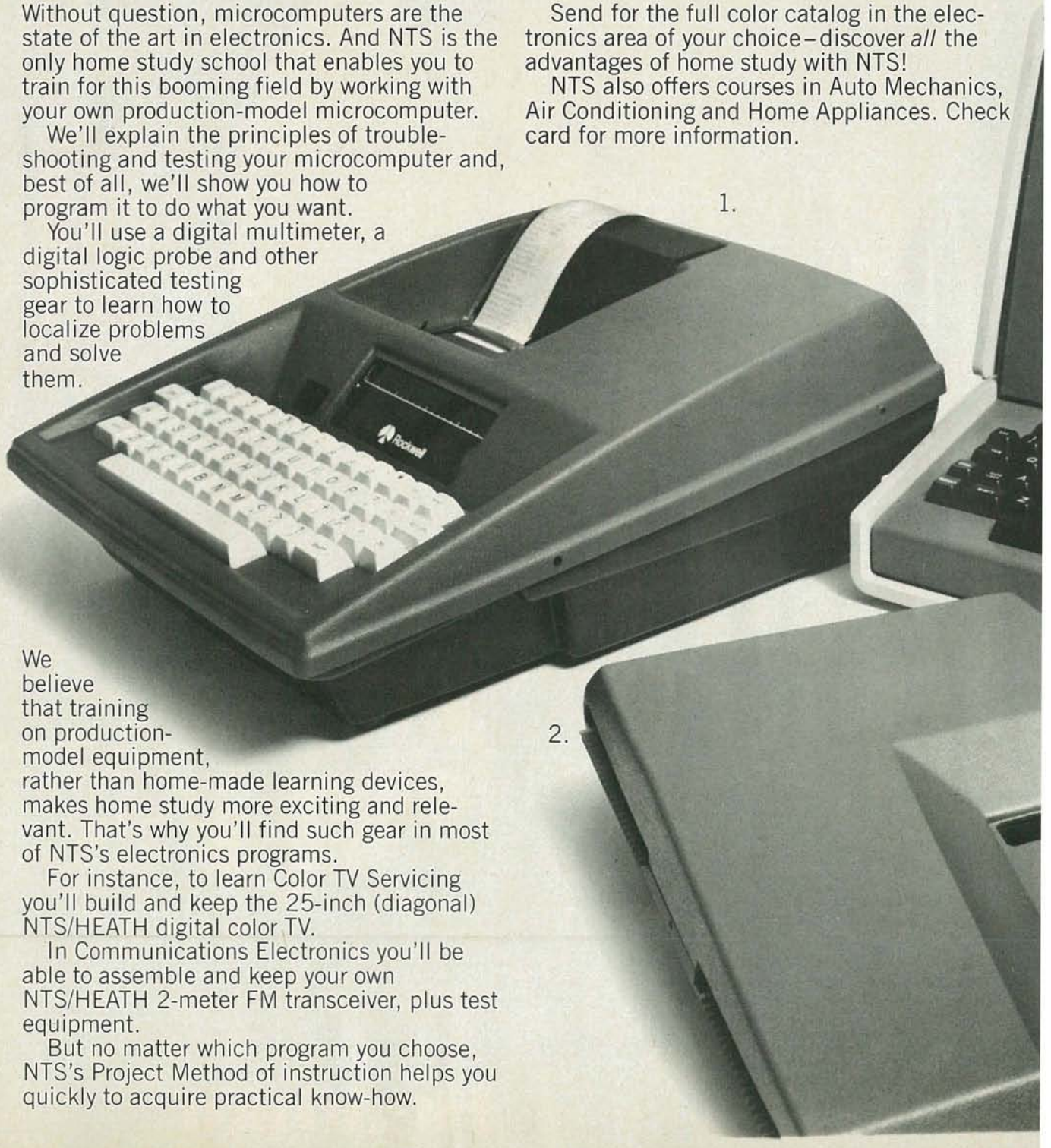

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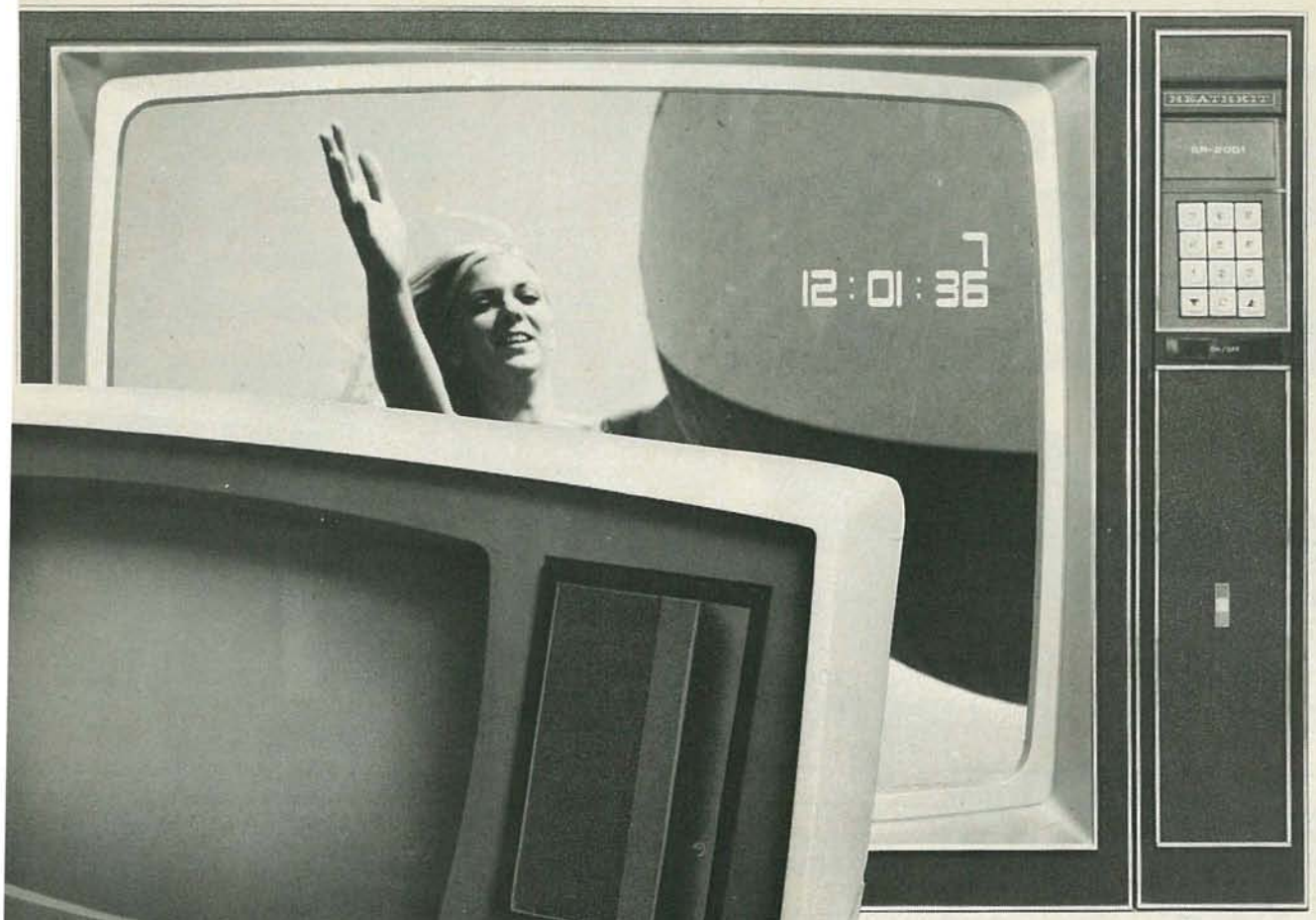

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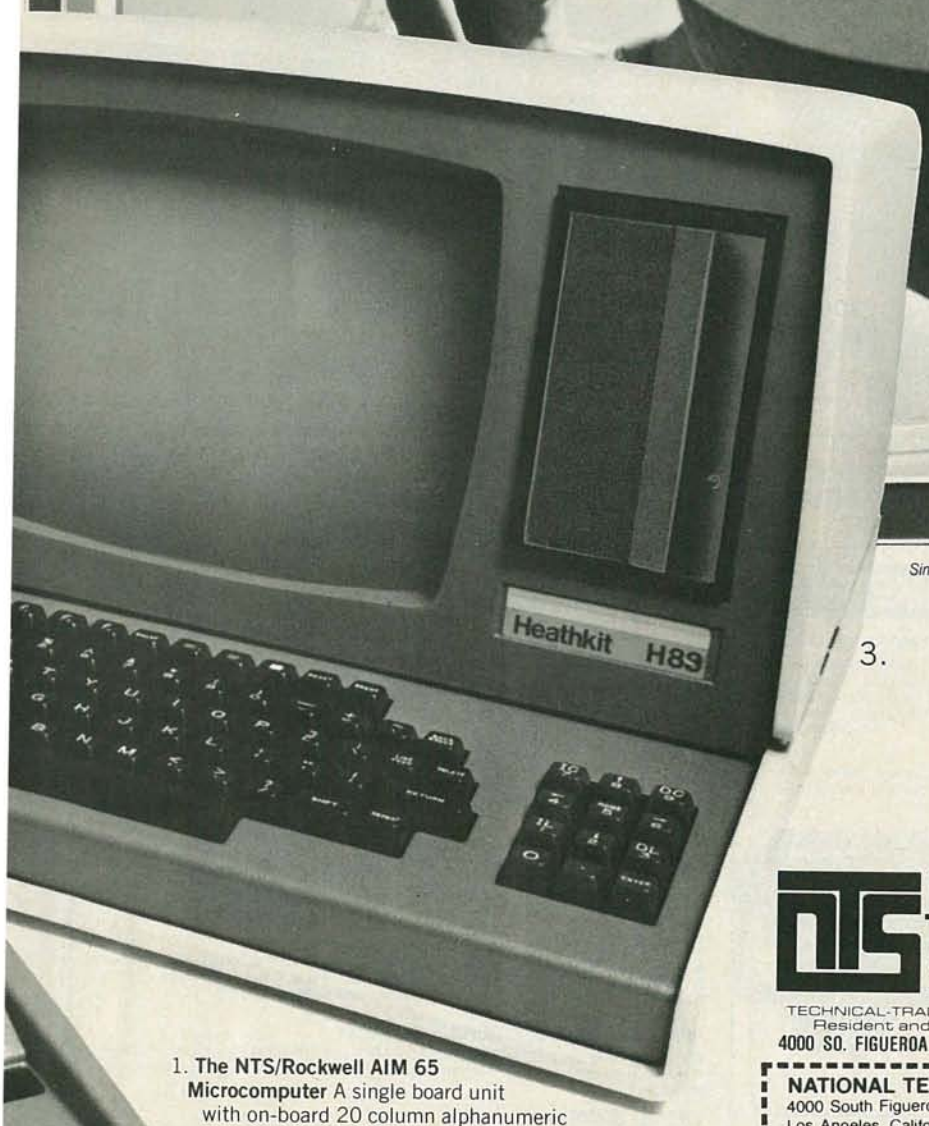

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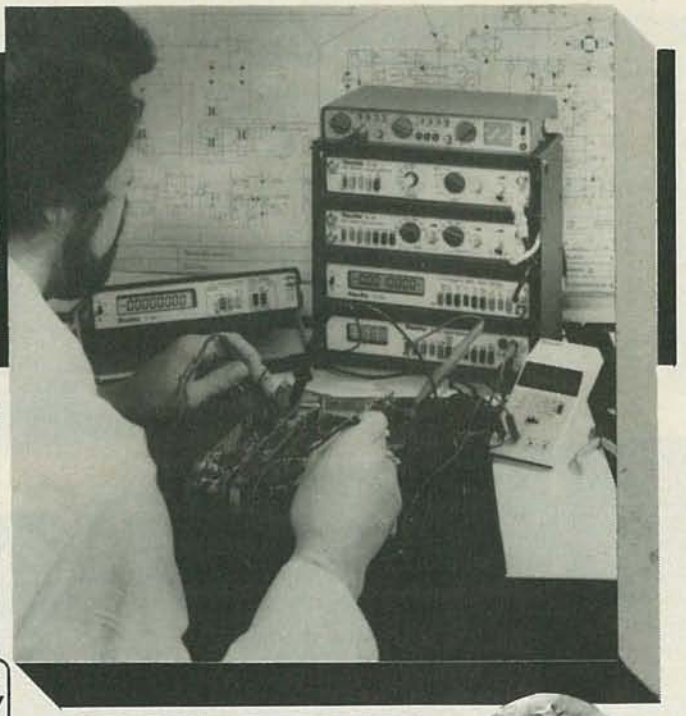

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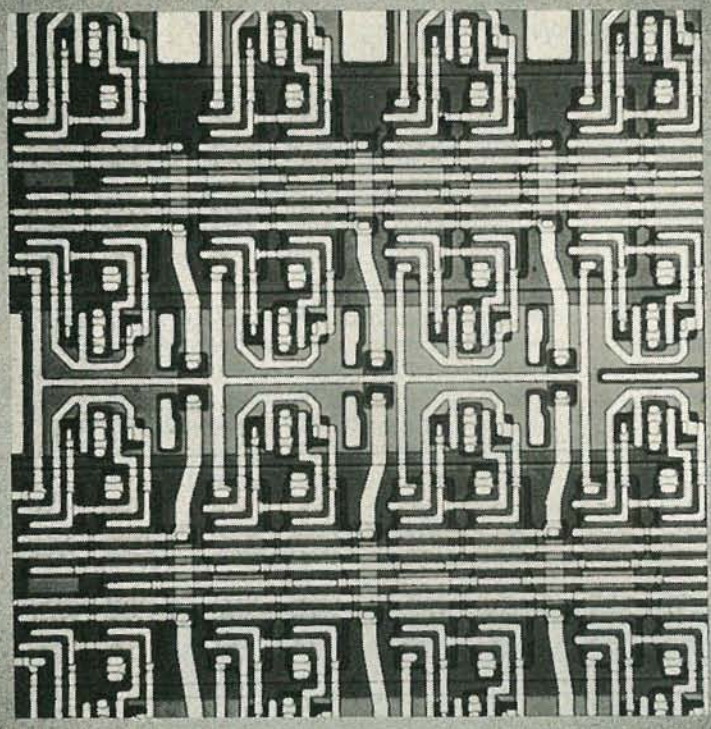
The Incredible Shrinking IC

Integrated circuit technology has come a long way from the first RTL flip-flop. Here's a look at the history of the IC, and a glimpse at its future.

BONAVENTURA ANTONY PATURZO



INTEGRATED CIRCUITS HAVE BEEN WITH us long enough now so that anyone who is at all familiar with electronics takes them for granted. But it really wasn't too long ago that the state of the art in computer logic was RTL (*R*esistor-*T*ransistor *L*ogic), and a tiny marvel called an IC op-amp was just appearing. Integrated-circuit technology has come a long way in the 20 years since the introduction of the first IC (a four-transistor, RTL flip-flop), but the best is yet to come. Let's take a look at how the IC came into being.

Ten years after Bell Laboratories' 1947 demonstration of their point-contact transistor, Jack Kilby, of Texas Instruments, set to work on building electronic circuits out of discrete semiconductor components. His intention was to show his superiors that entire circuits could be made out of a "solid" piece of semiconductor material. Early in 1959 such a "solid circuit" was shown at the Institute of Radio Engineers show. That circuit was a flip-flop and its resistors, capacitors, and transistors were made entirely from monolithic germanium.

At about the same time, Robert Noyce, then manager of research and development at Fairchild Semiconductor, decided to turn his own ideas into a practical device. (His ideas were to use diffused or deposited resistors, isolate on-chip devices with reverse-biased p-n junctions, and interconnect circuit elements through holes in the silicon dioxide by the evaporation of metal onto the surface of the wafer.)

Today Kilby and Noyce are both credited with the invention of the IC, although, at the time of their work, trends in the semiconductor industry already seemed to point to the development of integrated circuits. Advances in manufacturing processes had enabled semiconductor devices to saturate the market by 1960. One problem remained: As the products that used those discrete devices grew in complexity, the number of interconnections between the devices also grew. It reached a point where products couldn't be assembled quickly enough to use all of the available devices. What was needed, now that semiconductors were plentiful, were ways of speeding production of the end-product. The integrated circuit was the logical solution.

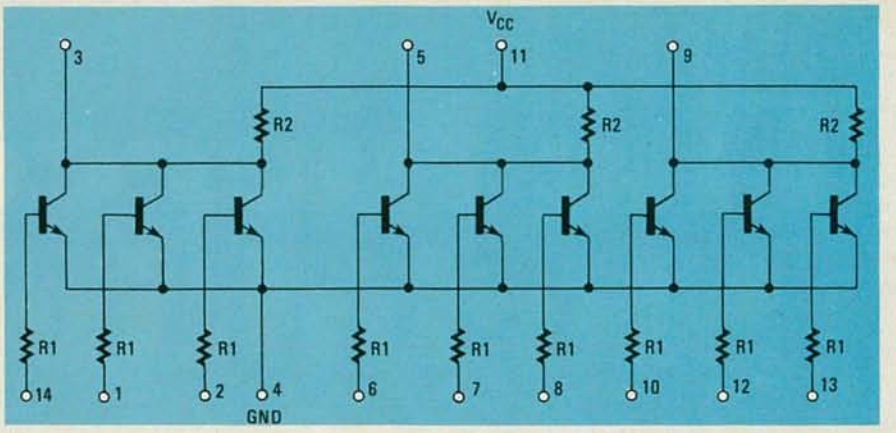


FIG. 1—SIMPLIFIED SCHEMATIC of a typical RTL device, the MC792P, a triple 3-input NOR gate.

The first IC's

The first commercially available monolithic IC was a four-transistor, RTL (*R*esistor-*T*ransistor *L*ogic) flip-flop introduced in 1961 by Fairchild Semiconductor. By the end of 1961, production quantities of logic IC's were being produced by both Fairchild Semiconductor and Texas Instruments. Some early contracts for the "mass-produced" IC's came from the military (TI supplied special circuits for the Minuteman missile program), and from the National Aeronautics and Space Administration, with Fairchild the supplier. An RTL circuit—a triple, 3-input NOR gate—is shown in Fig. 1.

*T*ransistor-*T*ransistor *L*ogic (TTL) came about because of the drawbacks of earlier schemes used to couple transistor stages. Diode-coupled and direct-coupled methods were unsatisfactory because of IC process-variations, and resistor-capacitor coupling suffered from lack of speed. In 1961, James Buie, an IC designer at Pacific Semiconductors (now part of TRW), devised a coupling scheme that isolated transistor stages by using coupling transistors; his method proved to be relatively independent of process variation. Buie's work evolved into today's TTL IC (see Fig. 2).

By the mid-1960's, Fairchild had turned to linear IC's. Robert Widlar, then one of the designers at Fairchild, was responsible for the first practical IC op-amp, the μA709. Widlar also designed the μA702 high-impedance op-amp, the first IC comparator (μA710), and the first compensated IC op-amp, the μA741. Widlar's design ideas seemed radical in his day because he used transistors to replace "simple" circuit elements such as resistors.

While bipolar IC technology was developing, some designers concentrated on the FET (*F*ield-*E*ffect *T*ransistor) and its applications. RCA Laboratories was especially active in that area of semiconductor development. In 1957 John Wallmark of RCA was granted a patent for an FET. He saw the FET not as merely a discrete device, but as groups of devices connected together and forming logic patterns for computers. His concept, which he called "integrated logic nets," wouldn't lead to actual devices until a few years later, and then under someone else's supervision.

In 1959 Steven Hofstein, a recent recruit to RCA, and Frederic Heiman, another young engineer, set to work towards a specific goal. They wanted to produce a silicon-insulated-gate FET that was to be used in a multi-thousand-transistor circuit. They succeeded in 1962. (See Fig. 3.)

Hofstein and Heiman demonstrated the IC capabilities of their MOSFET (*M*etal *O*xide *S*emiconductor *F*ield *E*f-

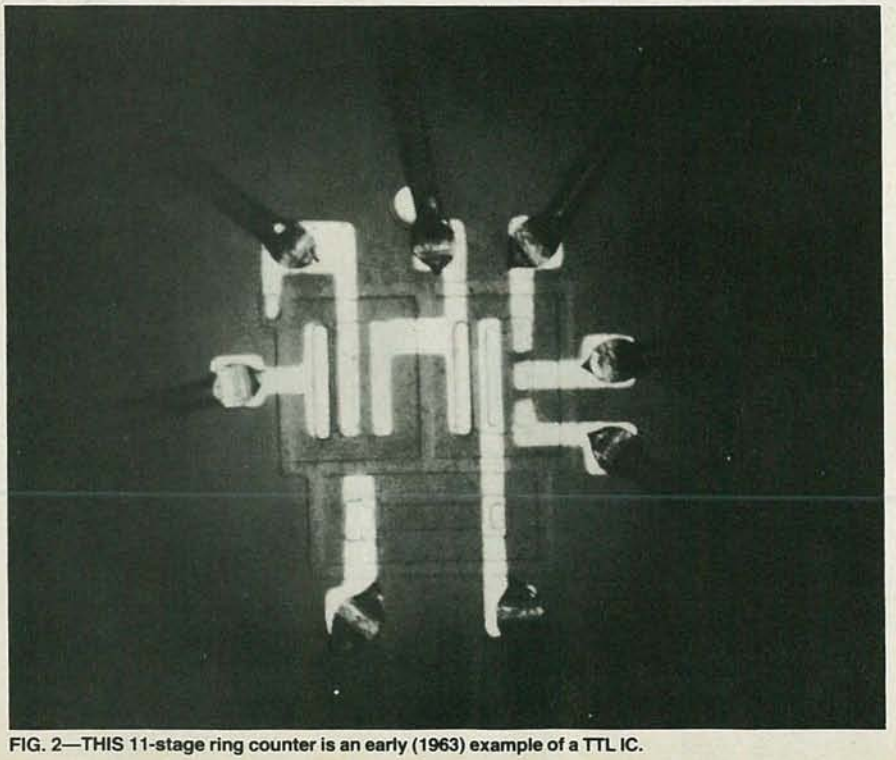


FIG. 2—THIS 11-stage ring counter is an early (1963) example of a TTL IC.

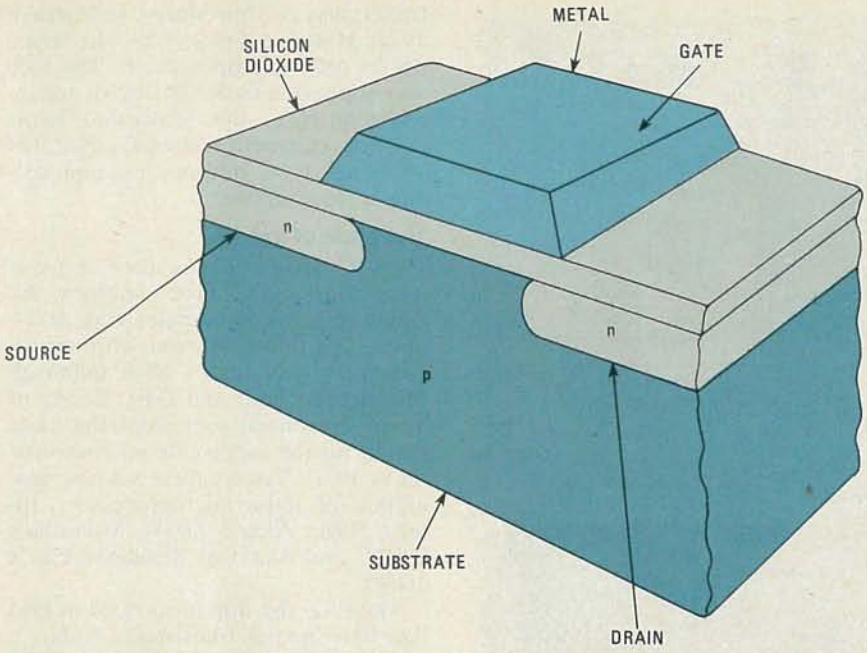


FIG. 3—CROSS-SECTION of a metal-oxide semiconductor device. By 1963, RCA had built IC's containing several hundred of these each.

fect *T*ransistor) by building a 2,500²-mil (a mil is 1/1000-inch) chip containing 16 MOSFET's by the end of 1962. By 1963 RCA had built chips with several hundred MOS devices.

Although MOSFET IC's promised far simpler processing, much less power consumption, and greater levels of integration than bipolar IC's, there were still formidable problems in their manufacture. Among those were oxide defects and an extreme sensitivity to static charge. The MOSFET's were also much slower and required different supply voltages than bipolar devices. Because of those problems, and others, few companies stayed very long with MOSFET technology. In fact, for most of the 1960's there were only two companies producing MOS IC's—General Microelectronics (founded in 1963) and General Instrument. Even RCA, which had done a considerable amount of pioneering work in MOS, shifted its main concern back to the more lucrative bipolar devices.

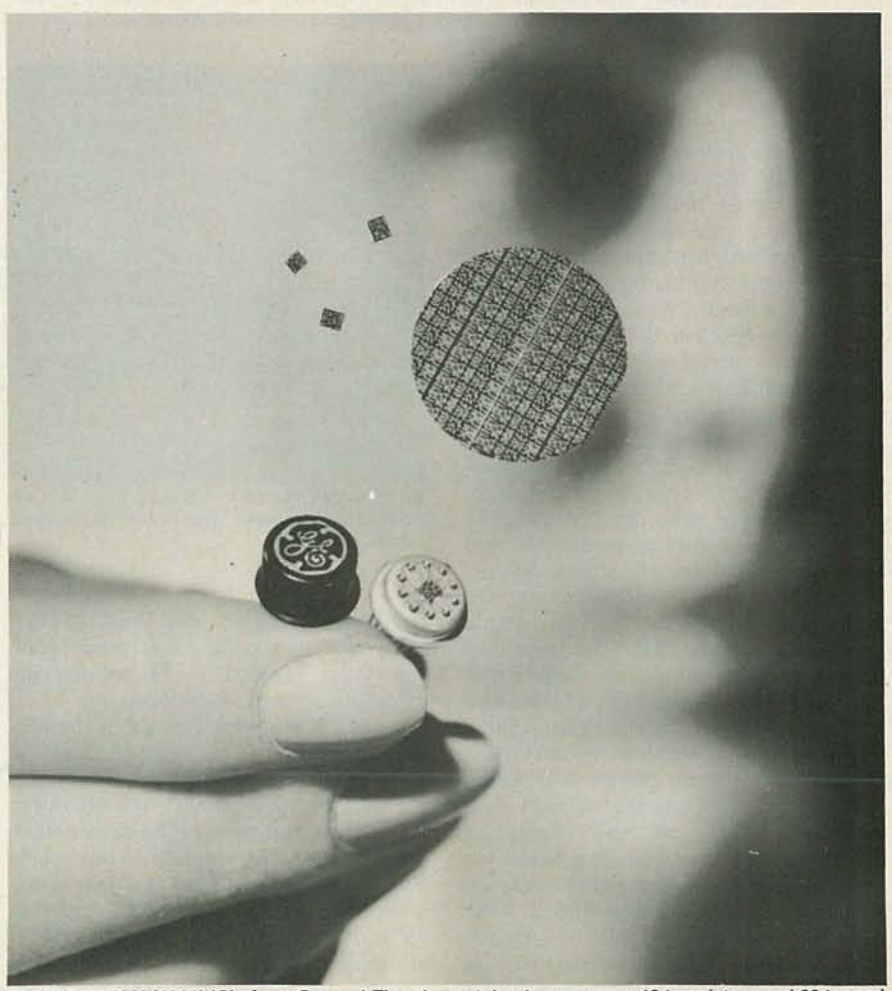
But the industry kept a watchful eye on MOS technology, waiting for new developments. The wait wasn't a long one, as we'll see.

The first ROM (*R*ead-*O*nly *M*emory) appeared in early 1967. Offered by Fairchild, the ROM was a 64-bit MOS device arranged into 16 4-bit words. A 1,024-bit ROM was offered by Philco-Ford a year later. As ROM's increased in density, the term firmware (for software in ROM) soon became popular.

Enter the microprocessor

In August 1969 Busicom Corporation of Japan commissioned Intel Corporation to design calculator IC's. At that time many of the MOS IC's produced in the United States went into calculators, and most of those calculators were made in Japan. Busicom wanted a set of IC's that would support a family of calculators, with ROM's used for customizing. Intel's design was approved by Busicom in October 1969 and in June 1971, Intel introduced the 4004 microprocessor family (designed by Federico Faggin, now president of Zilog). The 4-bit 4004 was the first microprocessor; it was built using p-channel MOS technology, and measured 150 × 110 mils. Just as the increasing complexity of discrete transistor circuits had seemed to point to the development of the integrated circuit, so too the increasing complexity of some random logic designs now seemed to show the need for a centralized computational/control element. Intel, however, was not alone in producing the "calculator-like" IC's. Fairchild, American Microsystems, Texas Instruments, Electronic Arrays, Rockwell, and Mostek all had contracts to build the devices. The MOS IC had truly come into its own. Shipments increased in one year from $15 million to $35 million and by the end of 1970, the total was over $100 million. The importance of MOS technology had grown faster than most people in the industry had expected.

Other advances in state-of-the-art IC manufacture accelerated the growth of an already expanding industry. The use of an electron beam to produce the masks used in IC photo-lithography rad-



THESE EARLY (1962) IC's from General Electric contained as many as 18 transistors and 66 tapped resistors. Contrast that with the component count of modern VLSI IC's.

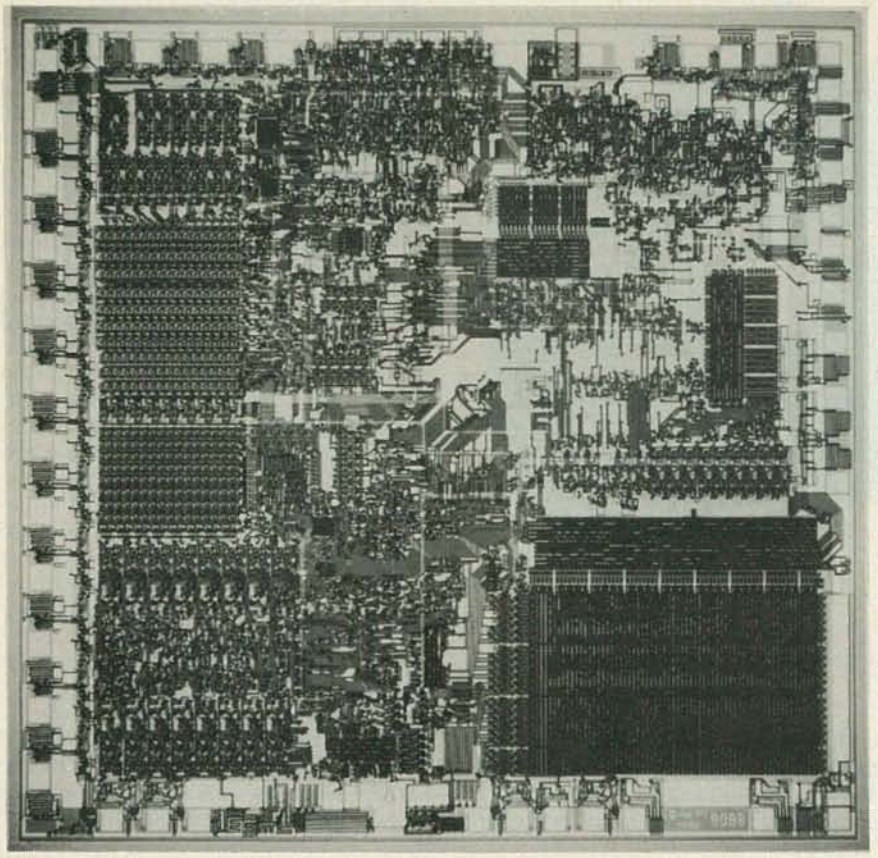
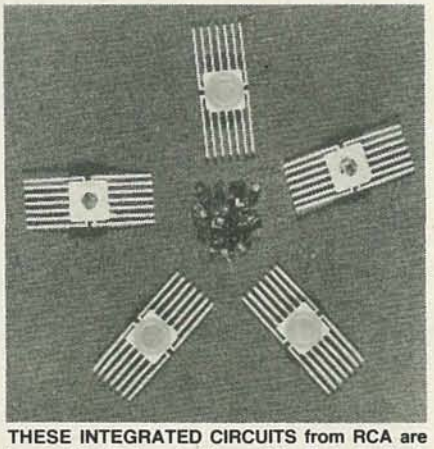


FIG. 4—THE INTEL 8086, a 16-bit LSI (Large-Scale Integration) microprocessor. Note the difference in density between this chip and the one shown in Fig. 2. (Photo courtesy Intel Corporation.)

ically changed one aspect of IC manufacture, as expensive and bulky ruby lithography equipment was made obsolete. As circuits increased in density and complexity, clean rooms became cleaner still. Doping (the introduction of impurity atoms into the silicon) methods were improved. Ion implantation, accelerating impurity ions into silicon using very high voltages, was a great improvement over thermal diffusion. Ion implantation's initial use was for high-density memories, with Mostek Corporation being the first to use the method in its 1K p-channel dynamic RAM (*R*andom-*A*ccess *M*emory). With increasingly complex circuits, IC manufacturers relied more on computer modeling programs and computer-assisted design for circuit analysis and mask layout.

The first 8-bit microprocessor, the 8008, was offered by Intel in sample quantities in early 1972. The price was $200. The 8008 could be interfaced to the standard memory products of the time, and with its 14-bit addressing capability, could address as many as 16,384 bytes. The 125 × 170-mil device was being shipped in "kits" (with memory and peripheral IC's) by the spring of 1973. By that time National Semiconductor had demonstrated its general-purpose controller/processor, a 4-bit microprocessor that could be used to build processors with word lengths of up to 32-bits. Rockwell had also joined the race with its own 4-bit parallel processor. AMI, Signetics, and Western Digital were also developing processors. Everyone seemed to be joining the microprocessor competition.



THESE INTEGRATED CIRCUITS from RCA are housed in "flat packs," one of the first standardized IC cases.

Intel's 8080 helped usher in the second generation of microprocessors. That n-channel device had four times the addressing capability and about ten times the throughput of the earlier 8008. The designer of the 8080, Masatoshi Shima, later left Intel to join Zilog where he designed the Z80. Early in 1974, RCA introduced the first CMOS (*C*omplementary *MOS*) microprocessor, the 1802; the TMS 1000, Texas Instruments' best-selling 4-bit microcontroller, was also introduced. In March of 1974, Motorola finally took the wraps off its 6800 microprocessor. The 6800 was supported by RAM, ROM, and interfacing IC's, plus Motorola's Exorcisor development system. By the fall of 1975, nearly 40 different microprocessors were available.

The state of the art

As IC designers took more of a systems approach to their creations, the single-chip microcomputer was developed. The first 8-bit single-chip microcomputer was Intel's 8048 (although Michael Cochran and Gary Boone of Texas Instruments received the basic patent for the single-chip microcomputer in 1971). Today, there's a new generation of 16-bit microprocessors: Intel's 8086, Zilog's Z8000, Motorola's 68000, and National Semiconductor's 16000.

The RTL flip-flop introduced in 1961 had four bipolar transistors. Today, a typical 16-bit high-performance microprocessor, such as the 68000, has 68,000 transistors. The recent introduction of the 64K RAM marked the beginning of a new phase of IC technology, VLSI (*V*ery *L*arge *S*cale *I*ntegration).

VLSI is still basically in the development stage. In 1978 the U.S. Department of Defense initiated its VHSIC (*V*ery *H*igh *S*peed *I*ntegrated *C*ircuit) development program, designed to provide an impetus for VLSI work, with an emphasis on speed. Contracts have already been awarded for the initial phase of the six year, $210 million program. Among other things the Federal effort hopes to develop devices with up to 250,000 gates, using circuit features as small as 0.5 micrometer (millionth of a meter). Contrast that with the 13,000 gates and 3.2 micrometer minimum circuit feature of the Motorola 68000.

How best to use VLSI technology is still uncertain, but one thing does seem sure: VLSI will be used to build ever denser memory chips, perhaps with a million bits or more of RAM, and with access times a fraction of that of today's fastest devices. Some say an entire mainframe computer will be possible with a handful of IC's.

Early in the 1970's, 20-micrometer line widths were common in IC circuit geometrics. By the mid-1970's those dimensions had been cut in half. As the decade ended, advanced devices with 3 to 4-micrometer line widths were available. Some say that devices with line widths of less than 1-micrometer will be common by the end of the 1980's.

Some views on the future of IC technology, especially those concerning the future of VLSI, take on an almost Christmas-wish aspect. Nevertheless, considering how far we've come from that first four-transistor flip-flop, the next 20 years could be very interesting indeed! **R-E**

BUILD THIS

SATELLITE TV ANTENNA

Before you can receive satellite television, you need the appropriate antenna. This inexpensive design can be built from common materials.

H.D. McCULLOUGH

IF YOU'RE A REGULAR READER, YOU'VE heard about TVRO stations—special setups used by cable-TV companies and others to receive the four-gigahertz (4,000 MHz) signals from satellites.

One of the most expensive components of a TVRO system is the antenna. The 8-Ball antenna described here is one of the few that you can build yourself and is relatively inexpensive and easy to align.

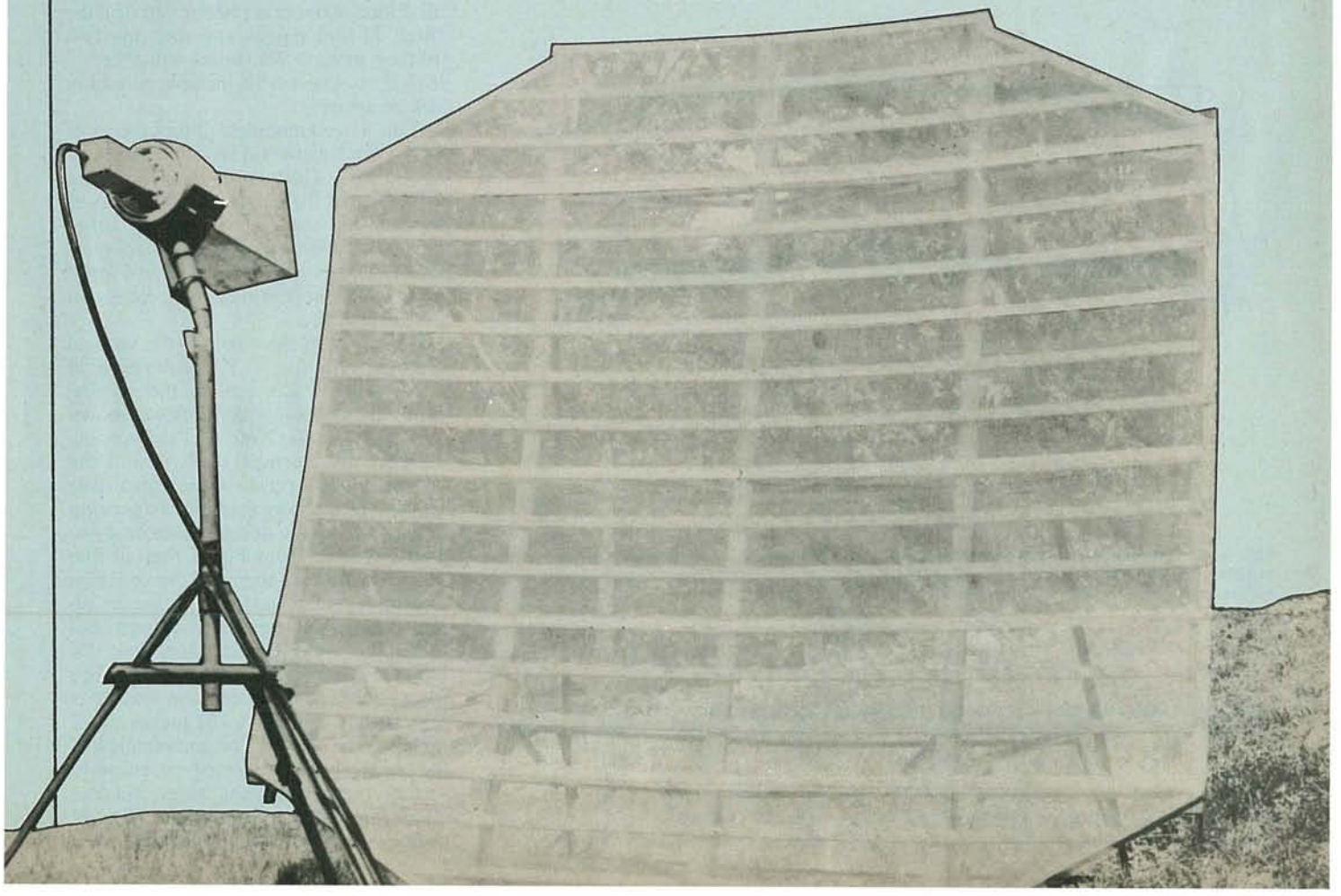
With it, and a couple of other special components, you can watch blacked-out sporting events, commercial-free movies, and other choice television fare usually available only on cable-TV systems.

What you need in addition to the antenna are an LNA (a special *L*ow-*N*oise *A*mplifier to boost the very weak signal picked up by the antenna) and a down-converter to process the 4-GHz TV signal so it can be viewed on an ordinary TV set. You can also purchase a special TV set that has a down-converter built into it if you wish.

Before going any farther, take a minute or two to study the various photographs of the antenna in various stages of assembly. The complete TVRO antenna consists of a 12-foot "dish" or reflector that captures the incoming signal and focuses it at the waveguide horn feeding the LNA. This article covers the construction of the dish. The 8-Ball's dish consists of two main sections. One is the steel frame that provides a rigid, durable support fixture. The other is the wood-lattice assembly to which the reflector surface (screen wire) is fastened. An important feature of this type of construction is that it is **not** necessary to build the heavy metal frame to close tolerances. However, you should keep all the metal ribs within a half inch or so of their intended positions.

The redwood lattice is attached to the frame with adjustable bolts about every two feet vertically and every three feet across. Those bolts allow the lattice (hence the reflector surface) to be adjusted to conform to the precise curve required. When adjusting the antenna, the vertical wood strips should be set to within a sixteenth of an inch of the exact curve.

The steel frame (see Fig. 1) consists of three horizontal ribs (HR1, HR2, and HR3) and five vertical ribs (VR1 through VR5) plus the rear legs and braces. The frame is made from 1/8-inch thick 1 1/2×



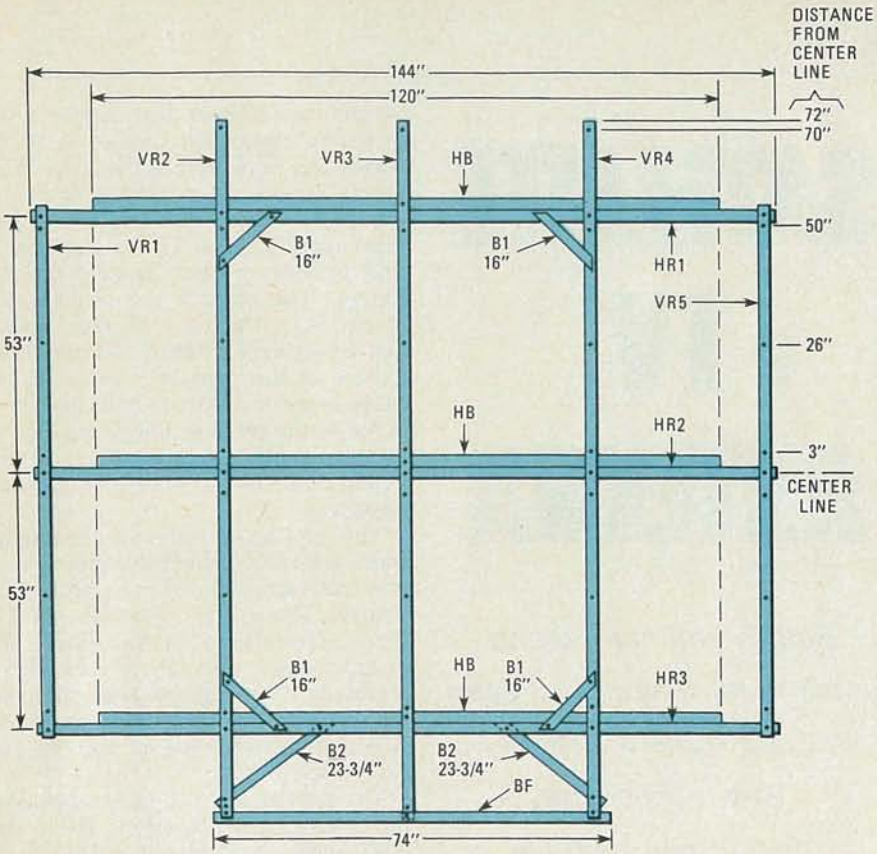


FIG. 1—THE METAL FRAME provides a rigid and durable support structure. The only critical factor in its construction is the setting of the angular bend in the three horizontal members.

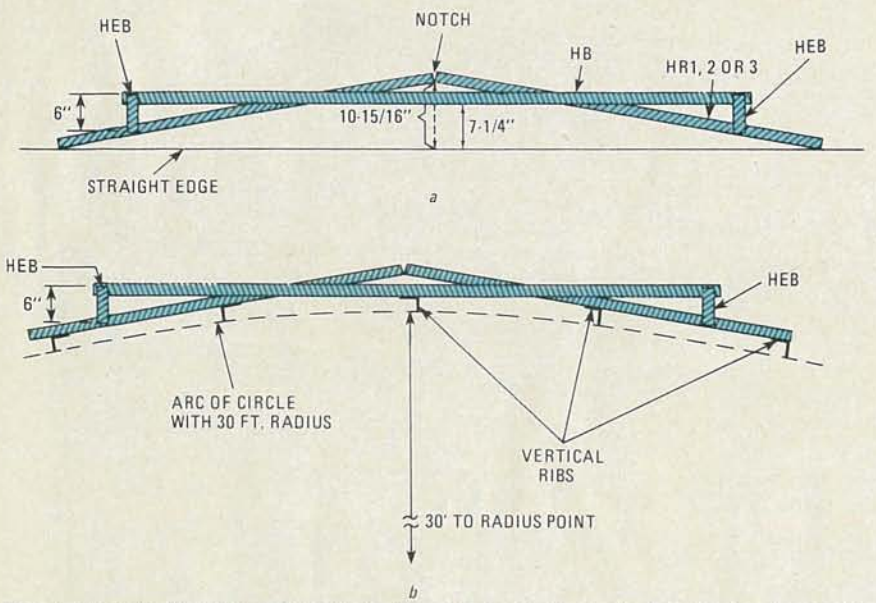


FIG. 2—THE HORIZONTAL CURVATURE of the 8-Ball reflector is developed by the bend in the horizontal ribs and by horizontal brace as shown in *a*. The five vertical ribs in *b* all lie on an arc that has a radius of 30 feet.

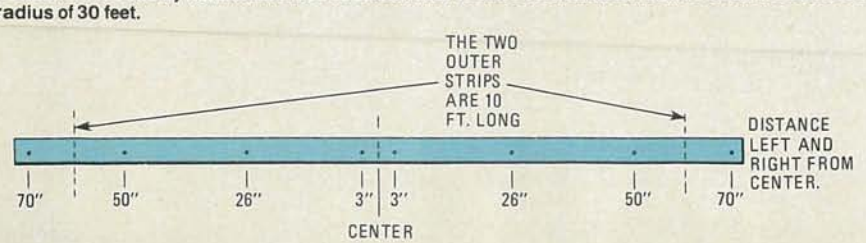


FIG. 3—THE FIVE VERTICAL LATTICE STRIPS are prepared by drilling holes according to the measurements shown. Three strips are 12 feet long with eight holes; two are 10 feet long with six holes.

1½-inch galvanized angle iron. Each horizontal rib is cut through at the center so it can be bent (see Fig. 2-a) and secured with a brace (HB) and end braces (HEB). The angle formed should be approximately 163 degrees. To establish the precise surface curvature with a minimum of final adjustments, the angle must be set very accurately.

A very small error in the location of the bolt holes where the brace and end braces are attached to the horizontal rib will cause a large error at the ends of the rib. Position the rib and braces according to Fig. 2-a and clamp them together with "C" clamps or locking-type pliers. Drill the holes and set the pieces aside temporarily.

When the horizontal brace is properly shaped and bolted, the angle and location of the brace will be such that the five points on each horizontal rib where a vertical rib is attached will lie on a circle with a radius of 30 feet as shown in Fig. 2-b. The procedure just described sets the curve of the frame and, therefore, the reflector surface in a horizontal direction.

Lattice preparation

There are five vertical lattice strips made of ¾×3-inch redwood. Two of the strips are 10 feet long, and three are 12 feet long. Prepare them by drilling holes according to the measurements shown in Fig. 3. The strips can be stacked and all drilled at once; or, better yet, drill the three 12-foot pieces and then the two 10-foot pieces. The holes will take ¼-inch bolts so use a 9/16-inch bit; assembly will be easier.

You'll need nineteen 12-foot pieces of ¾ × 2-inch redwood stock for the horizontal ribs. Thirteen of those are used as-is. To get the angles at the corners of the lattice (see Fig.4) cut two other pieces to 11 feet 4 inches, two pieces to 8 feet 10 inches, and two pieces to 6 feet 2 inches. The corner diagonal pieces will be covered later.

To establish the curve in the vertical direction, the five ¾ × 3-inch redwood strips will be attached to the vertical steel ribs with adjustable bolts as shown in Figs. 5 and 6. Note that the spacing between the vertical steel rib and the vertical wood strip is identical for all five vertical ribs at any specific distance up or down from the middle horizontal rib. Thus, we see from Fig. 5 that all five vertical strips are touching the steel ribs at their centers, and that 24 inches up and down from center, the space between the wood strip and steel rib is 13/16 inch *for all five of the ribs*. At 48 inches from each side of center, the spacing is 37/32 inches, and it is 7¼ inches at 72 inches from center. The combination of the vertical curve formed by properly setting the adjustment bolts and the curve formed by the horizontal ribs will establish a precise reflector surface.

PARTS LIST

Frame: The following are all 1½×1½-inch, ⅛-inch thick galvanized or primed angle iron.

Part no.	Length	Quantity
HR1	12 ft.	1
HR2	12 ft.	1
HR3	12 ft.	1
HB	10 ft.	3
HEB	6 in.	6
VR1	9 ft.	1
VR2	12 ft.	1
VR3	12 ft.	1
VR4	12 ft.	1
VR5	9 ft.	1
B1	16 in.	4
B2	23¾ in.	2
BF	74 in.	1
BR	104 in.	1
B3	32 in.	2
B4	59 in.	2
B5	30 in.	2
B6	30 in.	2
B7	83 in.	1
B8	92 in.	1
RL	8 ft.	2
RLX	4 ft.	2

Wood lattice strips (⅝ or ¾-inch redwood):

Size	Quantity
2 in. × 12 ft.	22
3 in. × 12 ft.	3
3 in. × 10 ft.	2

Bolts (¼×20 thread):

Length	Quantity
¾ in.	72
4 in.	10
5 in.	10
8 in.	10
12 in.	6

Miscellaneous (quantities in parenthesis):

¼-inch nuts (196)
¼-inch ID washers (72)
No. 8-1¼-inch brass wood screws (140)
aluminum screen (26 inches × 75 ft., 0.011 in. dia. wire, 1/16 in. mesh or heavy-duty 0.025 in. dia. wire, ⅛ in. mesh)
staples (rustproof)
glue
inclinometer
radius wire
anchor bolts (4)
"J" brackets (4)

Note: Some of these items will be called for in Part 2.

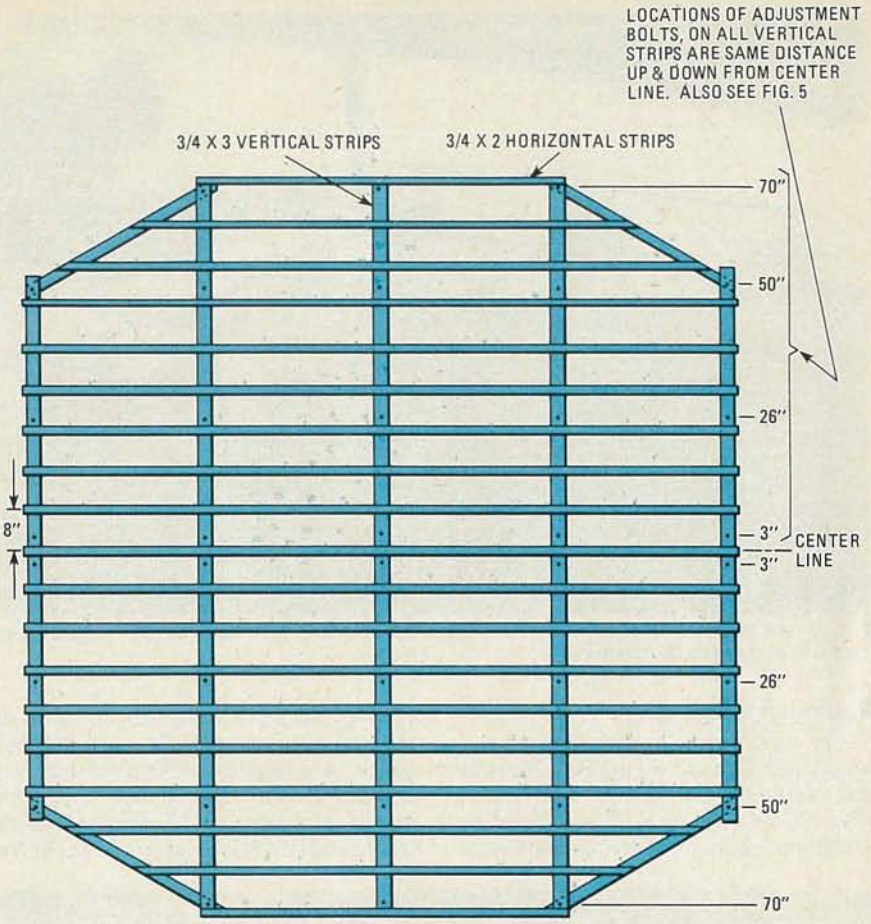


FIG. 4—THE REDWOOD LATTICE ASSEMBLY shows the locations of the 36 adjustment bolts. Those bolts set the curvature in a vertical direction. The arc of curvature is again 30 feet.

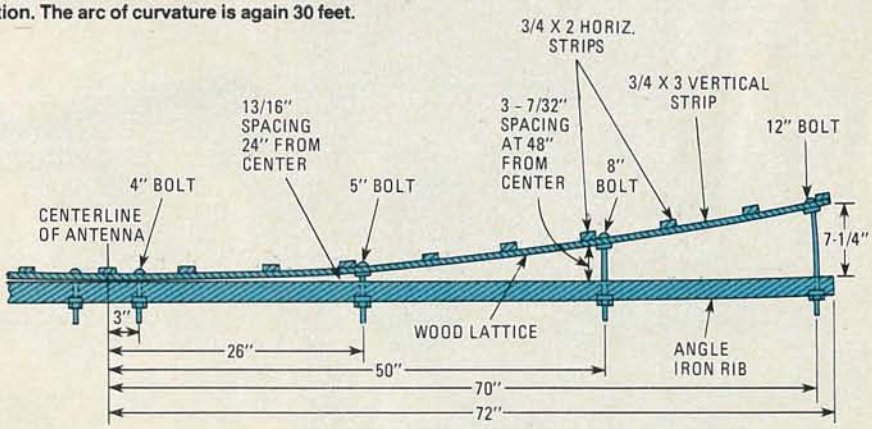
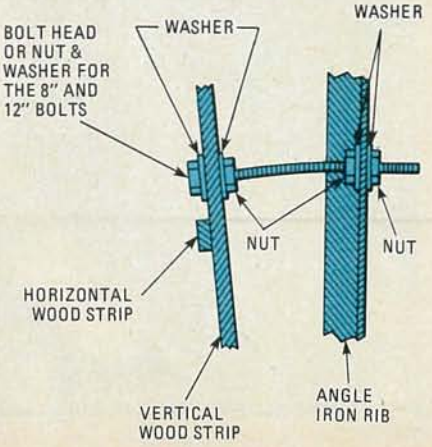


FIG. 5—SIDE VIEW of the top half of one vertical rib with wood lattice attached.

FIG. 6 (right)—DETAIL OF LATTICE ATTACHMENT showing use of nuts and washers on adjustment bolt.



Assembling the frame

Prepare each horizontal rib as shown in Fig. 2 by attaching braces HB and HEB with ¾-inch bolts.

Next, place the three horizontal ribs on blocks and attach the five vertical ribs as shown in Fig. 1 and Fig. 7. Use ¾-inch bolts. Note that, because of the braces, each horizontal rib will have a different number of holes drilled in it—so be sure to get the ribs in their proper positions. The top view in Fig. 2-b shows how the vertical ribs are positioned (note that the bottom of VR3 goes **under** BF).

Tighten the nuts only finger tight until all the pieces shown in Fig. 1 are installed and then tighten them securely. Whether assembling the 8-Ball from a kit, or from scratch, you'll find that some holes may not align perfectly. Make sure that everything is located properly, then align the holes with a tapered punch. Hold the pieces in place with clamping-type pliers while you insert the bolts.

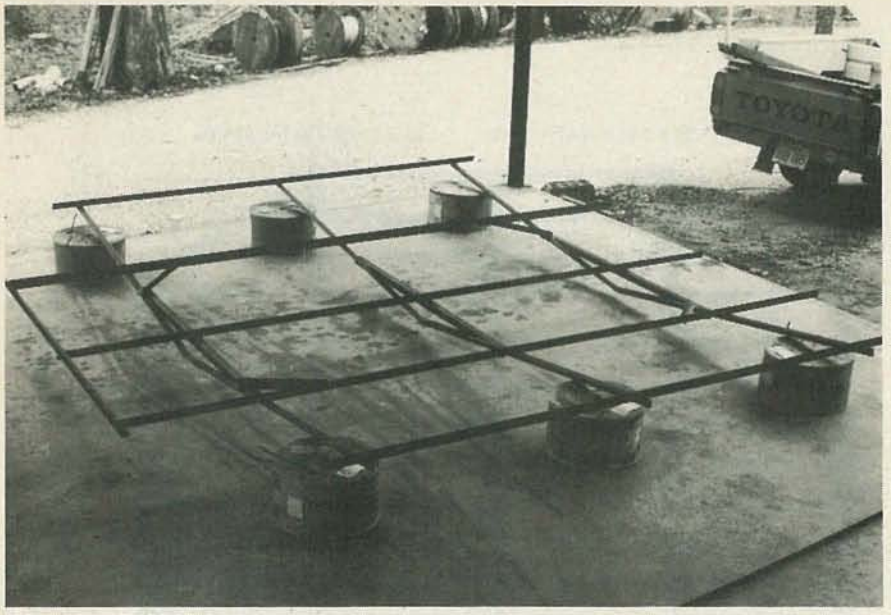


FIG. 7—THE THREE HORIZONTAL RIBS are supported on blocks while the three main vertical members are attached to the framework.

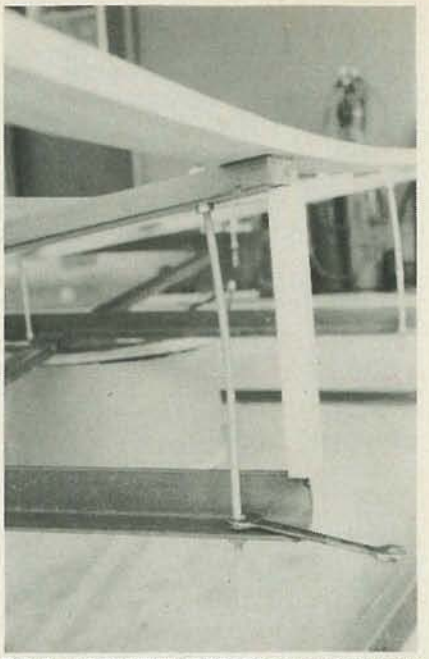


FIG. 9—ADJUSTMENT BOLTS are set for proper spacing between vertical frame rib and wood strip. Here a 7¼-inch spacer aids adjustment at 72-inch point.

Putting it all together

The next step is to assemble the redwood lattice as shown in Fig. 4. Mark all five vertical strips every eight inches (Fig. 8) for ease in positioning and installing the horizontal strips. Start at the center and work outward—it's a good idea to displace the first mark half the width of a horizontal strip so that you can line up the edge of each $^3/_4 \times 2$ with one of the marks. All 19 horizontal strips are spaced on 8-inch centers except for the very top and bottom strips. Those will be about $^3/_4$-inch closer in.

Now attach the adjustment bolts to the $^3/_4 \times 3$-inch vertical wood strips (except for the adjustment bolts at the ends of the two outermost strips) using the bolt lengths shown in Fig. 5. Note that the 8- and 12-inch bolts are actually

continued on page 78

FIG. 8—MARK ALL FIVE VERTICAL STRIPS every eight inches to make installing the horizontal strips easier.

The following are available from McCullough Satellite Systems, PO Box 57, Highway 62-East, Salem, AR 72576: The 12-foot 8-Ball Satellite Television Antenna Kit, $750.00. Includes everything except staples and concrete for mounting base. Frame is $1^1/_2 \times 1^1/_2$-inch angle iron with all pieces cut to fit and drilled. One coat of primer applied. All $^5/_8 \times 2$ and $^5/_8 \times 3$ redwood strips. Aluminum screen is 0.011-inch diameter wire in a $^1/_{16}$-inch mesh. Add $60.00 for heavy-duty mesh, $50.00 for extra bracing and $100.00 for galvanized frame.

The heavy mesh (0.025 inch diameter wire, $^1/_8$-inch mesh) is about $2^1/_2$ times as heavy as the regular mesh and will withstand abuse by hail, ice, etc. much better than the regular mesh. The extra bracing is necessary if you plan to move the antenna about. It makes the framework very rigid.

The 12-foot 8-Ball with galvanized frame, heavy mesh and extra bracing is a commercial-grade antenna named "Octasphere" and is available for $1195.00. Feed horn (fits LNA with WR-229 input): Sheet metal with brass flange, $40.00; Aluminum $60.00. RG-213 cable (loss 25 dB/100 feet at 4 GHz), $0.50 per foot. FM-8 cable (loss 13 dB/100 feet at 4 gHz), $0.60 per foot. Avantek 120° LNA (50 dB gain) $690.00 including DC block; $650.00 without DC block. All prices are FOB, Salem, AR.

Synthesized RF Generator

GARY McCLELLAN

The Programma-2 synthesized RF generator can be built for about $100, yet offers many of the same features found on commercial units costing over $3000.

THERE SEEMS TO BE A CRYING NEED FOR a good, low-cost RF signal generator on the average workbench. However, it appears that this is something that no manufacturer has realized yet. For the most part, you have to make do with an under-$100 RF generator that is usually kit-built and quite drifty. To compound the problem, the dial accuracy usually leaves something to be desired, and an external frequency counter must be used for calibration whenever high precision is required. The answer is to buy—or most often to lease—a frequency synthesizer when you need a high-performance RF signal-source. But since prices start at about $3200, owning one usually isn't too practical!

Enter the Programma-2 RF generator. Now, for less than 1/32 of the cost of a commercial model, you can build an RF generator with many commercial features. You get crystal-controlled accuracy at any frequency you select—typically ±0.0005%, short term. What that means is that if you set the unit for 30.01 MHz, the output is 30,010,000 Hz ± 150 Hz!

Since the unit is crystal controlled and incorporates a frequency synthesizer, any frequency you select will be locked tightly. The prototype drifts less than 10 Hz from a cold start—in an hour of operation. After that, any drift that occurs is negligible.

As far as features are concerned, this project covers a basic frequency range of 3 to 30 MHz in 10-kHz steps. Flip a switch and you get 300 kHz to 3 MHz in 1-kHz steps. Thus, this RF generator covers the frequencies most often used for IF/RF alignment, and for general experimentation. In addition, its RF output is rich in harmonics, allowing frequency coverage into higher parts of the spectrum.

Four thumbwheel switches allow you to set the exact frequency you want with ease; there's no squinting at a tightly packed dial. The switches make it easy to return to a specific frequency, and that makes alignment of equipment a lot easier!

Another important feature is a 50-ohm RF output. This low-impedance output allows you to use such accessories as attenuators, which are a must for low-level RF work. You can't use attenuators on conventional RF signal generators, and that makes some tests (like checking sensitivity) very difficult.

Other features include adjustable RF output, switchable AM/CW operation, and an error indicator.

Construction isn't too difficult, despite the device's many features. The electronics are on three PC boards. RCA-type connectors are used to simplify interconnecting the boards and to make adjustments or servicing easier in the future. The boards are all single-sided (most synthesizers require double-sided boards to keep system noise down) and can be easily made (or purchased—see Parts List).

All components used in this project have been on the market for at least three years, so you should have few problems in obtaining them. The tuning diodes (D201-D203 on the VCO board) may be difficult to locate. If that is the case, they can be special-ordered, although, since there are two different manufacturers for these parts, finding them may not be as difficult as you think.

Finally, a few words about calibration. Forget about conventional signal-generator alignment procedures. This unit can be aligned using only the built-in error indicator, and a receiver that can pick up one of the WWV transmitters. A frequency counter is helpful, but not necessary.

About the circuit

Let's get acquainted with the Programma-2 RF generator by taking a look at the circuitry. The boards contain a number of different circuits, and the time spent discussing them should pay off. It's hard to build an advanced project like this without knowing much about it. One thing though: you should have a basic knowledge of how frequency synthesizers work to appreciate this discussion. If you have followed my previous articles on synthesizer-type projects (see the June 1980, July 1980, and October 1980 issues of **Radio-Electronics**) you should have no problems.

This device is built on three PC boards—VCO, control, and switch (see Fig. 1). The VCO (*V*oltage-*C*ontrolled

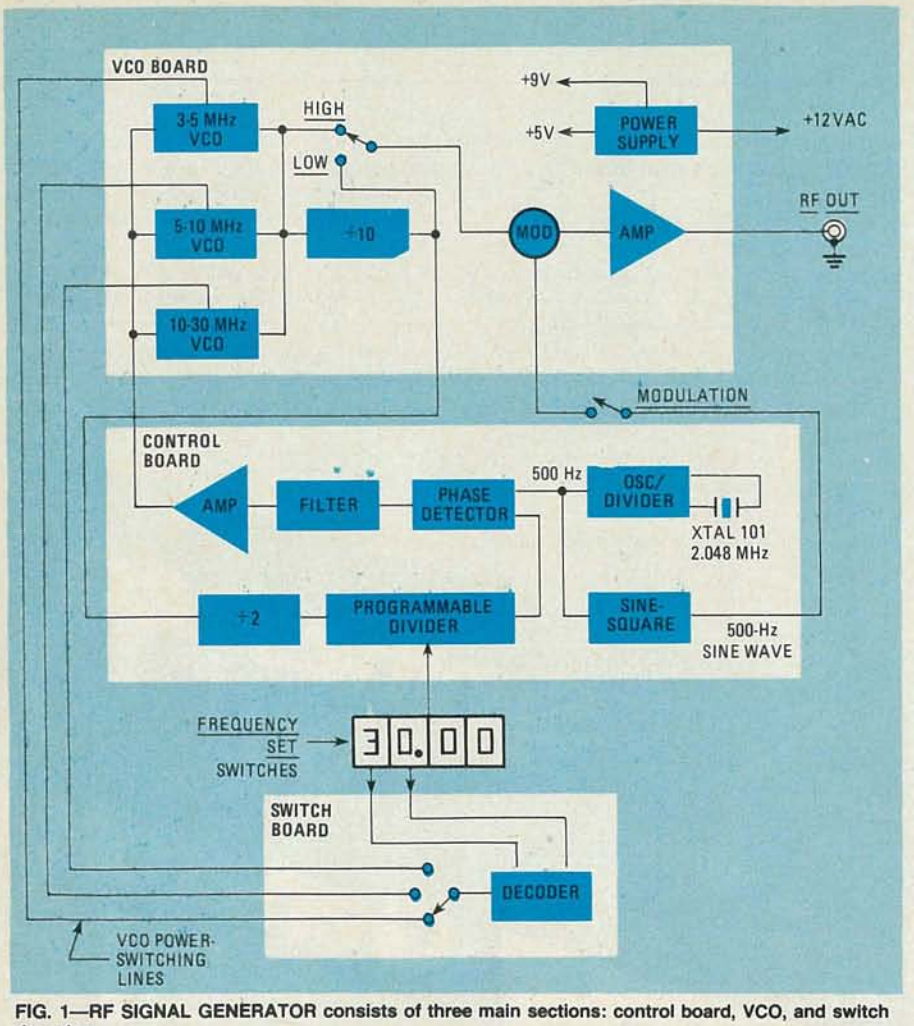


FIG. 1—RF SIGNAL GENERATOR consists of three main sections: control board, VCO, and switch decoder.

*O*scillator) board contains the RF-generating circuitry, a divider, an amplitude-modulation circuit, an RF power-amplifier and a power supply. That sounds like quite a bit, but actually each circuit block is very simple. The whole thing uses seven IC's and 1 transistor.

Next comes the control board, which contains a ÷2 divider, a programmable divider, a crystal-controlled reference, a phase detector, loop filter, amplifier, and sinewave converter. All that circuitry is compressed into six IC's and 1 transistor. Isn't IC technology wonderful? It would normally take a big card cage full of boards loaded with discrete components to replace just those small boards!

The last board is the switch board that contains a decoder and switches power to the proper VCO circuit, depending upon frequency.

Let's discuss each board in general, and then cover the control board specifically. The other boards will be discussed in greater detail later.

As you can see from Fig. 1, the VCO board contains the RF-generating circuitry. Three separate VCO's are required to cover a frequency range of 3 to 30 MHz because of the limitations of the tuning diodes used to set the frequency. It is prohibitively expensive today to make a single VCO sweep the entire range; 3 VCO's simplify things and keep the cost down. Following the VCO's, there is a simple divide-by-10 circuit that reduces the VCO frequencies to values needed by the control board. (Also, the output from the divider provides IF range frequencies, extending the range of this instrument down to 300 KHz)

The RF-output range is selected by the HI-LO switch. From that point, the RF signal goes through an amplitude-modulation circuit, which can add a 500-Hz tone to the signal if desired. The RF is amplified by a single-stage amplifier and goes to the RF-OUTPUT connector. The remaining circuitry on this board is a simple 5-volt and 15-volt power supply; the 5-volts is for on-board circuitry, while the 15-volts is for the control board.

The control board is an extension of the VCO board. It receives the divided-down signal from the VCO board, and divides it again by 2. This supplies a signal that the programmable divider can handle easily; such devices trade off speed for programmability. The programmable divider divides the input

PARTS LIST
CONTROL BOARD

All resistors ¼ watt, 5%, unless otherwise noted

R101-R115, R123, R124, R131—100,000 ohms
R116, R119—10,000 ohms*
R117—2200 ohms
R118—47 ohms*
R120—150 ohms*
R121—1 megohm
R122—68,000 ohms
R125, R126—33,000 ohms
R127—100 ohms
R128—5,000 ohms, trimmer potentiometer, horizontal PC-mount

Capacitors

C101—0.001 μF, ceramic disc
C102, C103, C114, C115—0.1 μF, 50 volts, Mylar*
C104—22 μF, 16 volts, tantalum*
C105—100 μF, electrolytic, 16 volts
C106-C108—0.1 F,μ16 volts, ceramic disc
C109—100 pF, ceramic disc
C110—220 μF, 6.3 volts, electrolytic
C111—5-35 pF trimmer (E.F. Johnson 275-0430-005 or equivalent)
C112—39 pF, mica
C113—68 pF, mica
C116—0.001 μF, 50 volts, Mylar

Semiconductors

IC101—CD4013 dual D flip-flop with set/reset
IC102—CD4059 programmable divide-by-n counter
IC103—CD4046 phase-locked loop
IC104—78L05 five-volt, 100 mA, regulator
IC105—CD4060 14-stage rippled counter
IC106—CA3130AE op amp (RCA)
Q101—2N3906 PNP
Q102—MPS-A13 Darlington, NPN
D101—1N5229 4.3-volt, 500 mW, Zener diode
XTAL101—2.048 MHz, 32 pF parallel-mode, ± 0.005%, HC-33/U case
S1-S4—BCD thumbwheel switch (C&K 332110000 or equivalent)
J101—8 pin IC socket

Miscellaneous: PC board, IC sockets, 4-conductor ribbon cable, wire, solder, etc.

***Do not substitute**

A complete set of three boards for the Programma-1 is available for $22.00 ppd. from: Technico Services, PO Box 20HC, Orangehurst, Fullerton, CA 92633. CA residents please add 6% tax; foreign orders please add $3.00 for shipping. Order No. SSG-1.

A complete set of *parts*, excluding boards, crystal, transformer and case, is available for $112.00 ppd. from: Circuit Specialists, Inc., PO Box 3047, Scottsdale, AZ 85281. Order No. KT-5. Phone orders (800) 528-1417; all other inquiries (602) 966-0764. AZ residents please add tax.

Crystal (see Parts List) may be obtained from: JAN Crystals, 2400 Crystal Dr., Ft. Myers, FL 33906. (813) 936-2397.

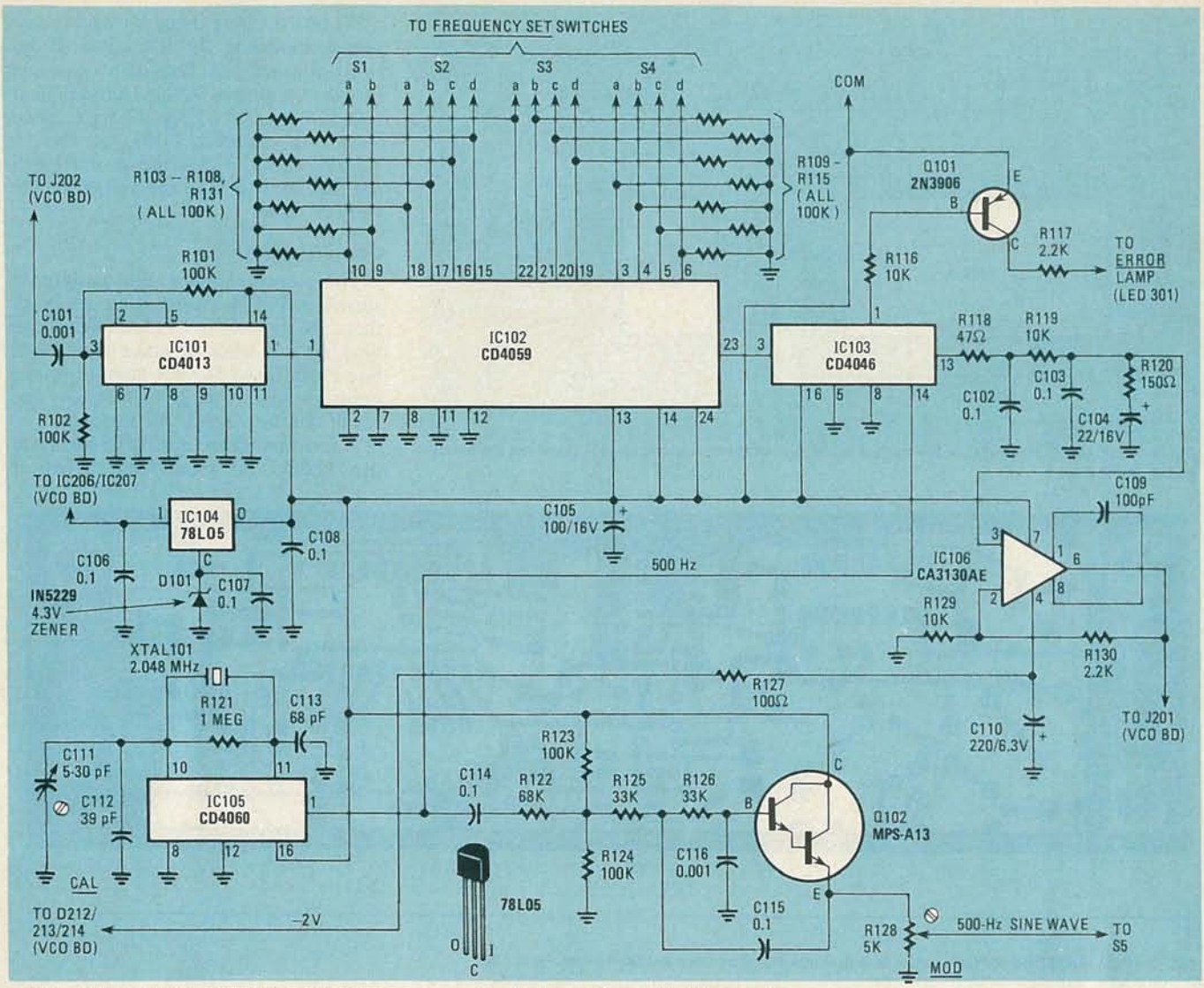


FIG. 2—HEART OF THE CONTROL BOARD is a programmable divider, IC102, used to determine the signal generator's output frequency from the switch settings.

frequency by whatever divisor has been set by the frequency switches, and outputs the resulting signal to the phase detector.

Meanwhile, a crystal-controlled clock circuit generates a 500-Hz signal that drives the phase detector. The detector compares the two signals and outputs error information to the filter, which removes any trace of 500-Hz signal. The DC voltage from the filter is fed to the amplifier, which raises it to levels suitable to drive the VCO's. Thus, the synthesizer loop is completed, and can generate RF signals set by the frequency switches. The remaining circuitry is a square-to-sine-wave converter. All it does is convert the 500-Hz clock-circuit pulses into a 500-Hz sinewave that drives the amplitude modulator, giving a clean-sounding tone.

The switch board is another extension of the VCO board. It selects the one of the three VCO circuits that matches the FREQUENCY-SET switch positions. For example, when frequencies between 03.00 and 05.00 are set on the switches, the 3-5 MHz VCO circuit is selected. Selection of the appropriate VCO is done by decoding the switch postions with a simple CMOS decoder on this board. The appropriate VCO is selected by switching power to it.

Control board theory

Let's discuss the first board to be built. Refer to the control board schematics, Figs. 2 and 3, for details as you read about it. The board uses CMOS IC's throughout. This type of design is used not only to keep power consumption down, but to minimize noise as well. CMOS logic tends to be a lot less noisy than TTL and the RF signal is cleaner. Besides that, CMOS blocks like the CD4059 programmable divider are far easier to work with than their TTL counterparts!

The circuit is quite straightforward. The divided-down RF signal is fed to the board's DIV input and drives IC101, a CD4013 divide-by-2 flip-flop. The input circuitry, C101 and R101/R102, is interesting—it acts as a level-translating interface. The signal at the DIV input is TTL level (0- or 5-volts) and all logic levels on the control board are 0- or 9-volts. Those components bias the CMOS flip-flop to the point where a TTL signal will drive it. The divided output from the flip-flop drives IC102, a CD4059 programmable divider. It divides the input signal by a frequency determined by the settings of the FREQUENCY-SET switches, and outputs the result.

Right now, that IC is one of the simplest and most effective (read "foolproof") ways of making a programmable divider. The output drives IC103, a CD4046 phase detector. The IC compares the signal from the divider with a 500-Hz reference, and outputs correction pulses to a loop filter that smooths them into a DC voltage. That's the job of C102-C104 and R118-R120. The phase detector also has an output that goes low when the two inputs are unequal. That drives transistor Q101 and lights the ERROR lamp on the front

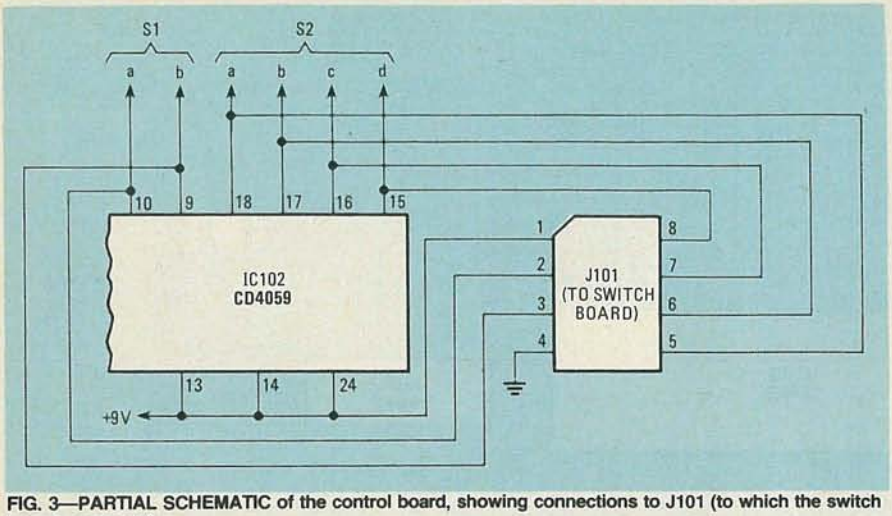


FIG. 3—PARTIAL SCHEMATIC of the control board, showing connections to J101 (to which the switch board connects).

VCO board where it can be used to amplitude-modulate the RF signal, if desired. Rounding up the circuitry on this board is a simple 9-volt regulator that uses IC104, a 78L05 5-volt device. Since 9-volts is required, D101, an 1N5229 4.3-volt Zener, is inserted in series with the regulator to raise the voltage to the correct value.

Construction

The control board foil pattern is shown in Fig. 4. (A complete set of all three PC boards is available for those who do not wish to make their own. See Parts List.) Do not attempt to use point-to-point wiring techniques—the result will be a noisy RF signal.

A few tips on the quality of parts you use should be mentioned. When it comes to substitutions, this project will tolerate *some* departure from the values called out. However, it isn't a good idea to make substitutions for the parts marked with an asterisk in the Parts List. Most of those components are in the loop filter, and deviations in value or quality will affect performance. Be sure you use Mylar capacitors where specified (those green capacitors often found in transistor radios). Also be sure to use tantalums where called for; other types may be too leaky and that will make the RF signal noisy. Be sure to get top quality parts and the instrument should give excellent performance and long life.

You may want to order the 2.048-MHz crystal right away. Generally, such crystals are made to order, and it takes about a month to get them. Give the supplier the specifications for XTAL101, and you should have one shortly. Price? About $5.00.

Next month, we'll finish building the Programma-2's control board and show you how to connect the unit's front panel FREQUENCY-SET switches to the board. **R-E**

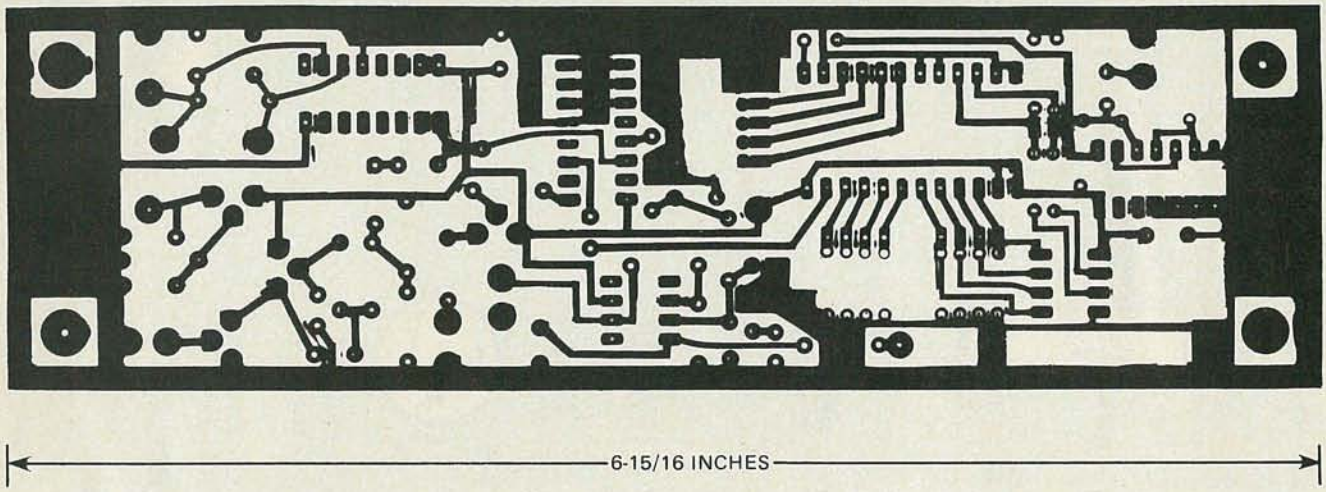


FIG. 4—FOIL PATTERN for the control board. Prepared boards are available—see Parts List.

FRONT PANEL of the completed Programma-2 synthesized RF generator. Its layout gives the unit a professional appearance.

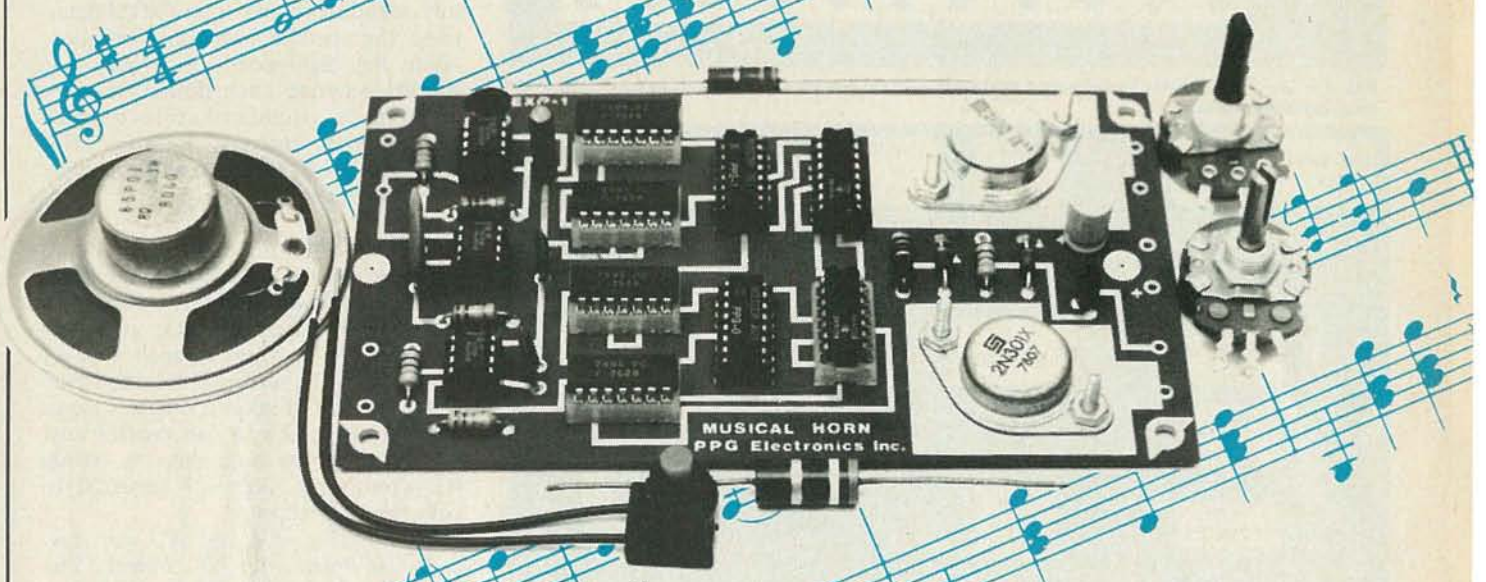
panel. The user can easily tell if the instrument is putting out the right frequency or not.

The loop filter's output drives IC106, a CA3130 op-amp. That device is used to increase the voltage from the loop filter so that it can drive the tuning diodes on the VCO board. It's just a noninverting amplifier with a gain of 2.2.

The 500-Hz reference signal is generated by IC105, a CD4060 oscillator/divider circuit. That IC has a Pierce crystal-oscillator that works with XTAL101 to produce a 2.048-MHz signal. The signal is divided down to 500 Hz by a set of binary dividers. The 500-Hz output serves as the phase-detector reference, as outlined earlier, and generates clock pulses for the square-to-sine-wave converter.

Capacitor C114 and resistor R122 integrate the squarewave into a rough triangle wave that is then filtered into a smooth sinewave by the Q102 circuitry. The output, which appears at the MOD terminals, goes back to the

BUILD THIS Musical Horn For Your Car



FRED BLECHMAN and DAVID McDONALD

It's said that "music hath charms to soothe the savage beast." Build this musical horn for your car and find out whether that's true during rush hour.

THE FIRST AUTOMOBILES, TRAVELING AT the breathtaking speed of 15 miles per hour, used warning horns operated by squeezing a large rubber bulb to force air through an orifice. As the car evolved so did the horn, going through the "aah-oog-aah" mechanical contraption to the standard electronically-operated-diaphragm horn that has been in use for years. Now you can move into the space age by building your own electronic musical horn for under $35.

The Musical Horn is designed for 12-volt vehicles and uses digital integrated circuits and programmable read-only memories (PROM's) to generate virtually any desired tune, depending on the PROM's installed. Pre-programmed PROM's are available for several tunes (see parts list). The popular "La Cucaracha" is described in detail here.

How it works

You don't have to understand how the Musical Horn works to use it. The discussion that follows is expressed in lay terms for the electronics-oriented non-musician, to describe how the digital circuitry creates the musical notes.

Music is composed of sound of specifically related frequencies (notes) that are sustained for particular durations (beats). Consequently, if we can generate those frequencies in proper relationship to each other, and provide a means to control their duration, we can make music!

The musical scale

There are several different musical scales (tone-series with specific frequency relationships) in use throughout the world. In the United States, the standard scale is the Equally Tempered Chromatic Scale, using the American Standard pitch of A=440 Hz. By definition, the frequency of each note is exactly $2^{1/12}$ (two-raised-to-the-$^{1}/_{12}$th-power or 1.0594631) times the preceding note. This is most easily shown on a piano keyboard, a section of which is illustrated in Fig. 1 with the frequency of each key. The circled numbers are reference numbers for use later.

Our challenge is to generate electronically a range of specifically related frequencies. Obviously, separate oscillators could be used—a very expensive and complicated approach. Or, we could have a single master oscillator and provide numerous "taps"—using resistors or capacitors—to generate each note. That approach is used in many inexpensive toy electronic organs. We're going to do it digitally, though... and without a keyboard.

The approach used here is shown in block-diagram form in Fig. 2. Twelve-volt car-battery power is regulated to supply 5-volts to all IC's. A variable low-speed clock triggers an 8-bit up-counter that is initially set to zero when power is applied. The counter's binary output sequentially addresses a 256-location "song" PROM. Each location contains a 4-bit binary code that defines which of 16 possible notes should be generated at that moment.

The 4-bit binary code that appears on the output of this PROM is the "note command" code, and is directed to one set of inputs of a data comparator. Meanwhile, a variable high-speed clock strobes another 8-bit up-counter whose

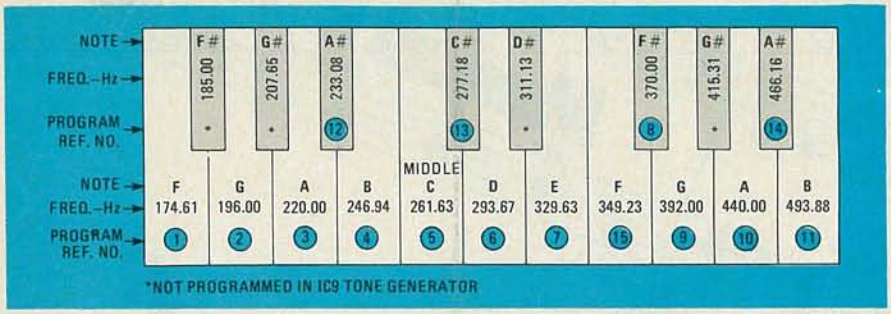


FIG. 1— 1½ OCTAVES on a piano-style keyboard. Circled numbers refer to values contained in the tone-generation program.

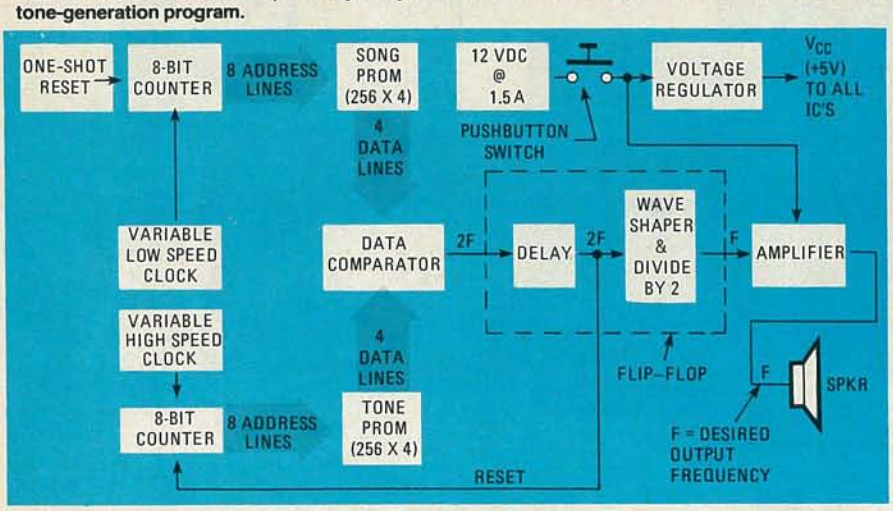


FIG. 2—HEART OF THE MUSICAL HORN is the data comparator, which determines when, and for how long, each tone will sound.

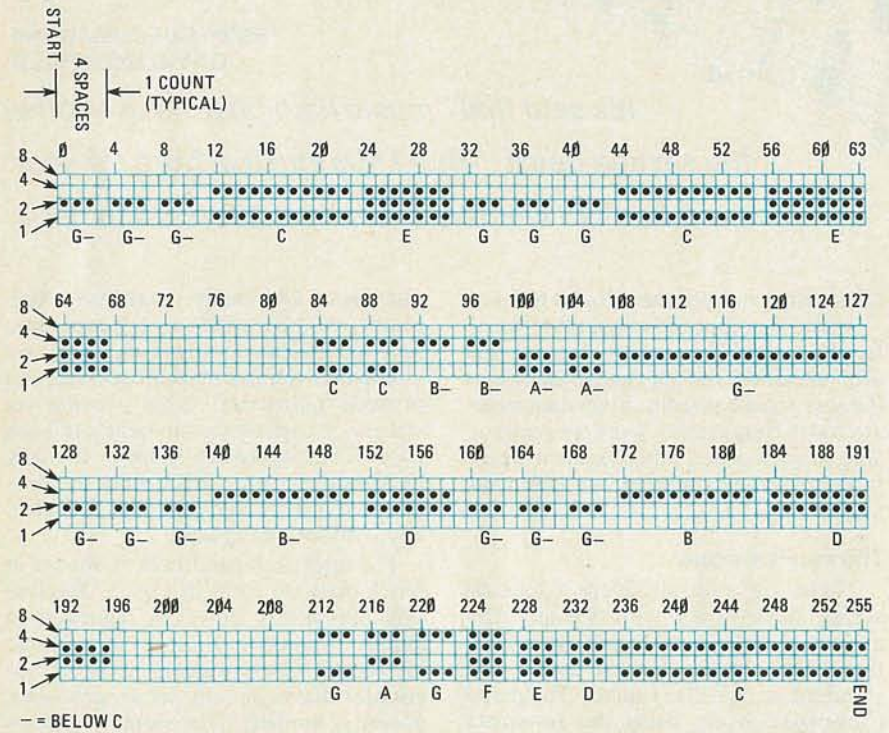


FIG. 3—SONG PROGRAM for "La Cucaracha." Program starts at upper left. Dots represent logic-highs; blanks, logic-lows.

binary output sequentially addresses a "tone" PROM with 256 locations. Certain specific addresses in this PROM contain a 4-bit code that corresponds to one of 15 possible tones, or a space (no tone). At these specific note locations, the 4-bit code for the desired note appears at the PROM's output, and is directed to the *other* set of data-comparator inputs.

When the two data comparator inputs correspond exactly, the comparator outputs a pulse to a flip-flop used as a delay element and wave-shaper. The output of the delay portion of the flip-flop passes the pulse back to the high-speed 8-bit counter and resets it to zero. The second section of the flip-flop changes the pulse to a square wave at one-half of the pulse frequency. The square wave is then amplified and fed to a speaker. The transistor amplifier is operated directly from the 12-volt supply.

What all this amounts to is that the low-speed clock and song PROM determine the specific notes and duration, while the high-speed clock and tone PROM generate each desired note by counting the number of cycles to reach an addressed memory location. This will become clearer as we go through the circuit in detail.

How it works

Figure 4 is the schematic of the horn. A 555 astable multivibrator, IC1, with C1, C2, R1, R2, and R3, generates pulses at pin 3. Their frequency is determined by the setting of R1, the TUNE-SPEED control. It takes 256 pulses for an entire tune, and you can control how fast the complete tune plays by setting R1—from very slow (27 seconds) to very fast (2.3 seconds).

Two 7493's, IC4 and IC5, are cascaded to form an 8-bit counter. The pulses from IC1 clock IC4, a divide-by-16 binary counter. The QØ, Q1, Q2 and Q3 outputs go to IC8 to address the least-significant four bits, AØ, A1, A2, and A3, of the 8-bit input. The Q3 output of IC4 (every 16th pulse) also clocks IC5, another divide-by-16 counter, whose QØ, Q1, Q2 and Q3 outputs form the most-significant four bits—A4, A5, A6, A7—to complete the addressing to IC8. Wherever power is applied (switch S1 held closed) IC2 puts out a momentary logic-high pulse at output Q, which resets both IC4 and IC5 to zero. Now each clock pulse from Q of IC1 causes the address to IC8 to advance by one location, from zero to 255. The outputs of IC8, data lines DØ, D1, D2 and D3, are inputs to data comparator IC10 at AØ, A1, A2 and A3.

The song program

Looking back at Figure 1, notice that most keys have a circled number indicated, as well as a frequency. The circled number is a decimal number from 1 to 15 to represent that particular note. Zero is no note—that is, silence. Not all the keys are numbered, since the 4-bit binary code used in programming these numbers only allows for Ø-15 in decimal.

The number 5, for example, represents middle C (261.63Hz). Now look at Fig. 3, the actual programming of IC8 for "La Cucaracha". Start at the lower left corner. The first horizontal row is memory address Ø. Each row shows four vertical columns. Each column has a decimal value, going from left to right, of 8, 4, 2, and 1. You may recognize this as a binary sequence, or a 4-bit binary code. A black dot in a column signifies a

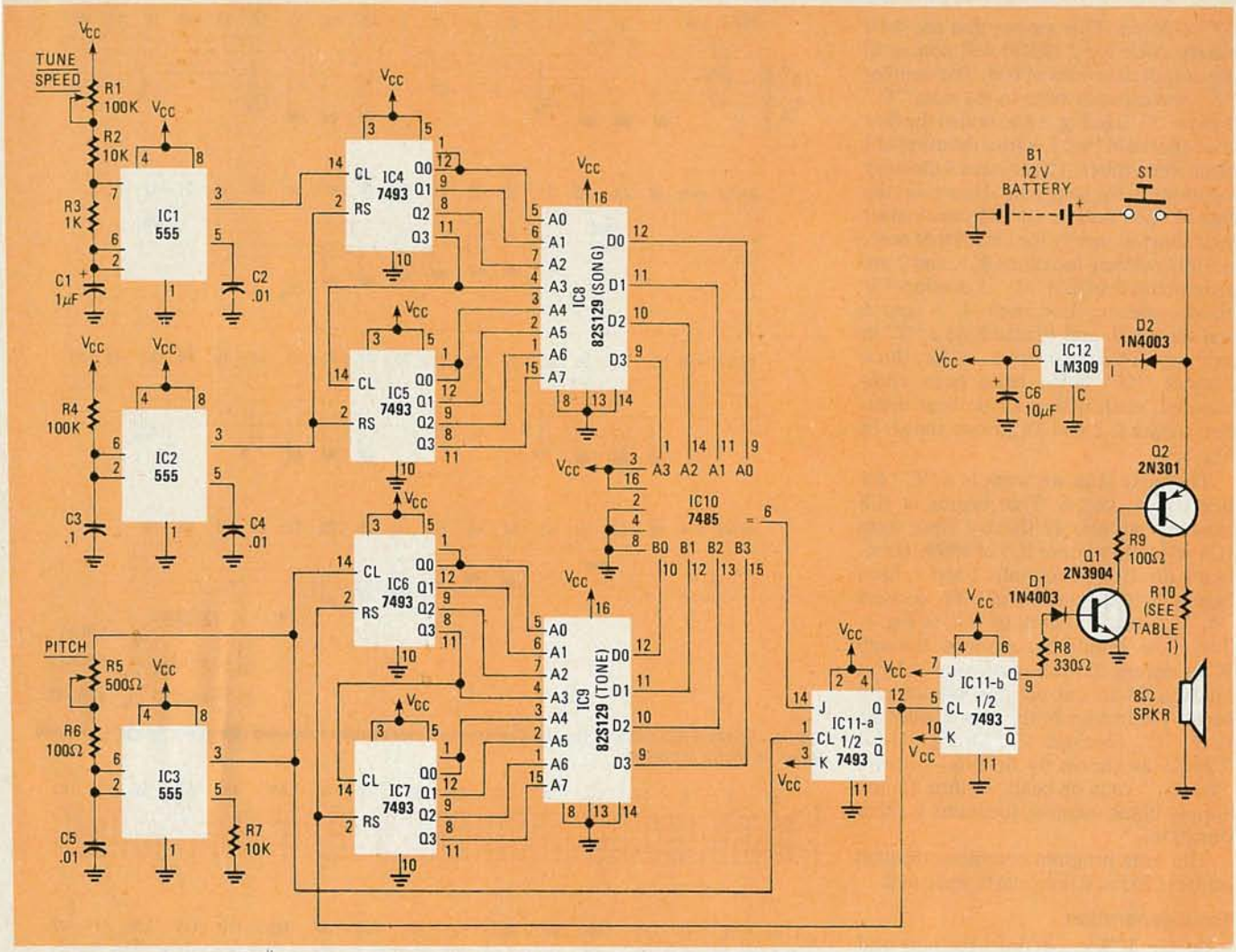


FIG. 4—MUSICAL HORN SCHEMATIC. Transistor Q2, a 2N301, is a special germanium type—do not attempt to use a silicon-type in its place.

PARTS LIST

Resistors ¼-watt, 5% unless otherwise specified
R1—100,000 ohms, potentiometer
R2, R7—10,000 ohms
R3—1000 ohms
R4—100,000 ohms
R5—500 ohms, potentiometer
R6, R9—100 ohms
R8—330 ohms
R10—see Table 1

Capacitors
C1—1 μF, electrolytic
C2, C4, C5—0.01 μF, ceramic disc
C3—0.1 μF, ceramic disc
C6—10 μF, electrolytic

Semiconductors
IC1-IC3—555 timer
IC4-IC7—7493 4-bit binary counter
IC8, IC9—N82S129 or equivalent 256 × 4-bit PROM (see below)
IC10—7485 4-bit magnitude comparator
IC11—7473 dual JK master/slave flip-flop
IC12—LM309K, LM340K or 7805K 5-volt regulator
Q1—2N3904 or similar
Q2—2N301
D1, D2—1N4003, 200 PIV
S1—N.O. momentary pushbutton switch

Miscellaneous: PC board, 8-ohm speaker or horn, IC sockets, hardware, etc.

NOTE: The following are available from PPG Electronics, Dept. RE, 14663 Lanark St., Van Nuys, CA 91402: Complete kit including PC board and all parts except case and IC8 (No. 1082), $39.95; PC board only (No. 782), $11.95; IC9 tone PROM (PPG-0), $6.95; IC8 song PROM ("Cucaracha": PPG-1, "Dixie": PPG-2, "Charge": PPG-3), $6.95 each; 2N301 output transistor, $1.99. Add $2.00 shipping & handling for orders within U.S. CA residents please add 6% tax.

"1" or logic-high output; a blank indicates a "Ø" or logic-low output. The "1" column corresponds to data line DØ of IC8; the "2" column controls data line D1; "4" controls D2, and "8" determines the output at D3. Putting all that together, the black dots for each row (memory address) of IC8 determine the logic states of the four data-output lines. When IC4 and IC5 input an address to IC8, what they do in effect is to look at the contents of that address and set the output data lines to the corresponding logic levels.

Confused? Well, another sketch (Fig. 5) and some examples will help. The musical notation shown in Fig. 5 is nonconventional in some respects, but more easily understood by non-musical readers. A "solid" note with a stem is 1 beat, which occupies four memory addresses in the song IC (IC8). An "empty" note with a stem is 2 beats, and needs 8 memory addresses. The legend shows the other symbols and the number or beats associated with them. Each note is shown conventionally on the staff; C is shown one line below the staff, for example. The numbers above the staff represent beats—a total of 64 for the entire tune. (64 beats times 4 addresses per beat equals the total of 256 addresses in IC8).

Looking at Fig. 3 again, we see that address Ø (binary ØØØØØØØØ from IC4 and IC5) contains a black dot in only the

"2" column. This means that the 4-bit binary code for 2 (ØØ1Ø) will appear at the output data lines of IC8. The number "2" corresponds here to the note "G" (below "C") in Fig. 1 and is also the first note shown in Fig. 5, with a duration of 1 beat. Remember, 1 beat takes 4 memory locations in the song chip. However, the end of each note is cut off one-quarter beat short to signify the end of that note, so only address locations Ø, 1, and 2 are programmed with a "2". Location 3 is blank—silence. Locations 4, 5, and 6 and then 8, 9, and 10 also hold a "2" in memory. This means that, so far, three distinct "G" notes have been commanded, each with a single beat duration (beats 1, 2 and 3), just as shown in Fig. 5.

The next note we want is a "C" for beats 4, 5, and 6. That begins at IC8 memory address 12 (binary input from IC4 of 11ØØ and from IC5 of ØØØØ). Here, black dots are in columns 4 and 1, for a binary output from IC8 of Ø1Ø1, decimal "5." This corresponds to "C" in Fig. 1. The note duration continues through IC8 address 22, followed by a zero at address 23 to cut off the note after 3 beats. Addresses 24 through 30 play the note "E" (decimal "7" in Fig. 1) for 2 beats as shown by the Fig. 5 score. "Rests," such as beats 18 thru 21, are simply blank memory locations for that duration.

The tune program continues through address 255 and then starts again at Ø.

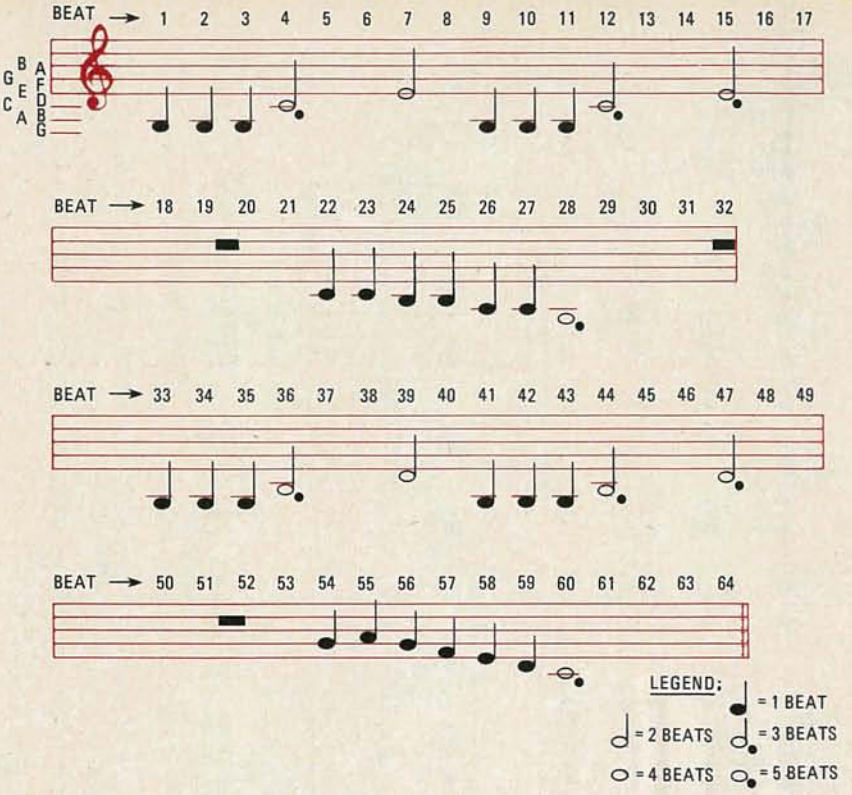


FIG. 5—SIMPLIFIED SCORE for "La Cucaracha." Horizontal rectangles represent "rests"—periods when no music is played.

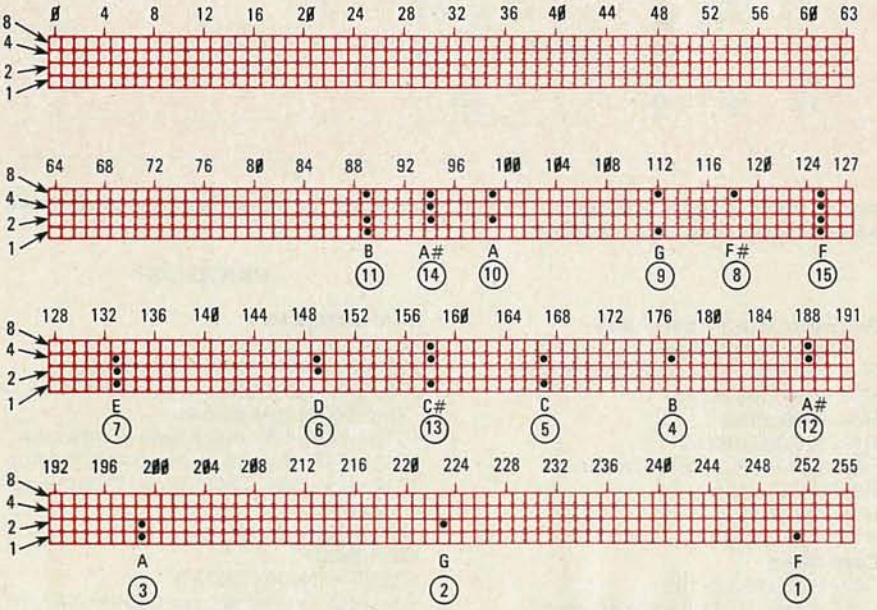


FIG. 6—TONE GENERATOR program. Start reading at upper left. The lower the number assigned to a note, the lower its frequency (see text).

Tone generation

So far, IC8 has defined the note and duration commands, but how do the notes actually get generated? Refer back to the schematic (Fig. 3).

Another 555, IC3, with capacitor C5 and resistors R5, R6, and R7, generates pulses at pin 3 at a frequency determined by the setting of PITCH potentiometer R5. Those pulses are from 500 to 1000 times faster than the tune-speed pulses from IC1. The IC3 pulses clock binary counter IC6, which cause IC6 and IC7—another pair of 7493's—to upcount in the same manner as described earlier for IC4 and IC5. The 4-bit binary outputs of IC6 (least-significant bits) and IC7 (most-significant bits) form an 8-bit address word for IC9, another 256 × 4 PROM. That PROM is specially programmed to generate tones. Figure 6 shows the memory locations for each note in IC9. Here's how a tone is generated:

As IC6 and IC7 count upwards at the frequency generated by IC3, the output of IC9 at each count is that contained by the memory location addressed at that instant. That output is fed from data lines DØ, D1, D2, and D3 to the BØ, B1, B2, and B3 inputs of IC10, a 7485 data comparator. Remember that the binary output of IC8 at that point is being fed to the "A" inputs of IC10, which is looking for an exact match at its "A" and "B" inputs. Only when the "A" and "B" inputs of IC10 are identical does IC10 generate a logic-high output at pin 6. As IC6 and IC7 address the memory locations of IC9, most locations are "blank" (all zeros). Finally, at decimal address 89 the binary number 1Ø11 appears (decimal 11 or musical note "B" in Fig. 1). This is, at that moment, the "B" input to IC10. If the "A" input also has this same input (1Ø11) then pin 6 of IC10 goes high, and IC6 and IC7 are reset to zero by a pulse from pin 12 of IC11-a. If, however, the "A" input is *not* 1Ø11, but instead is the command for a *different* note, then IC6 and IC7 keep counting upward. Decimal address 94 contains the binary code 111Ø (decimal 14), which would be the next lower frequency musical note, "A#," in Fig. 1.

We'll finish discussing how the Musical Horn generates tones when we conclude this article next month. We'll also give you some pointers that will help make building and troubleshooting the circuit much easier. After all that's done, we'll show you how to mount the Musical Horn in your car. **R-E**

BUILD THIS

Part 3

BEFORE YOUR COMputer can communicate using the modem you've constructed, it has to be programmed to behave like a terminal. Let's take a close look at the software that's needed.

A terminal emulator

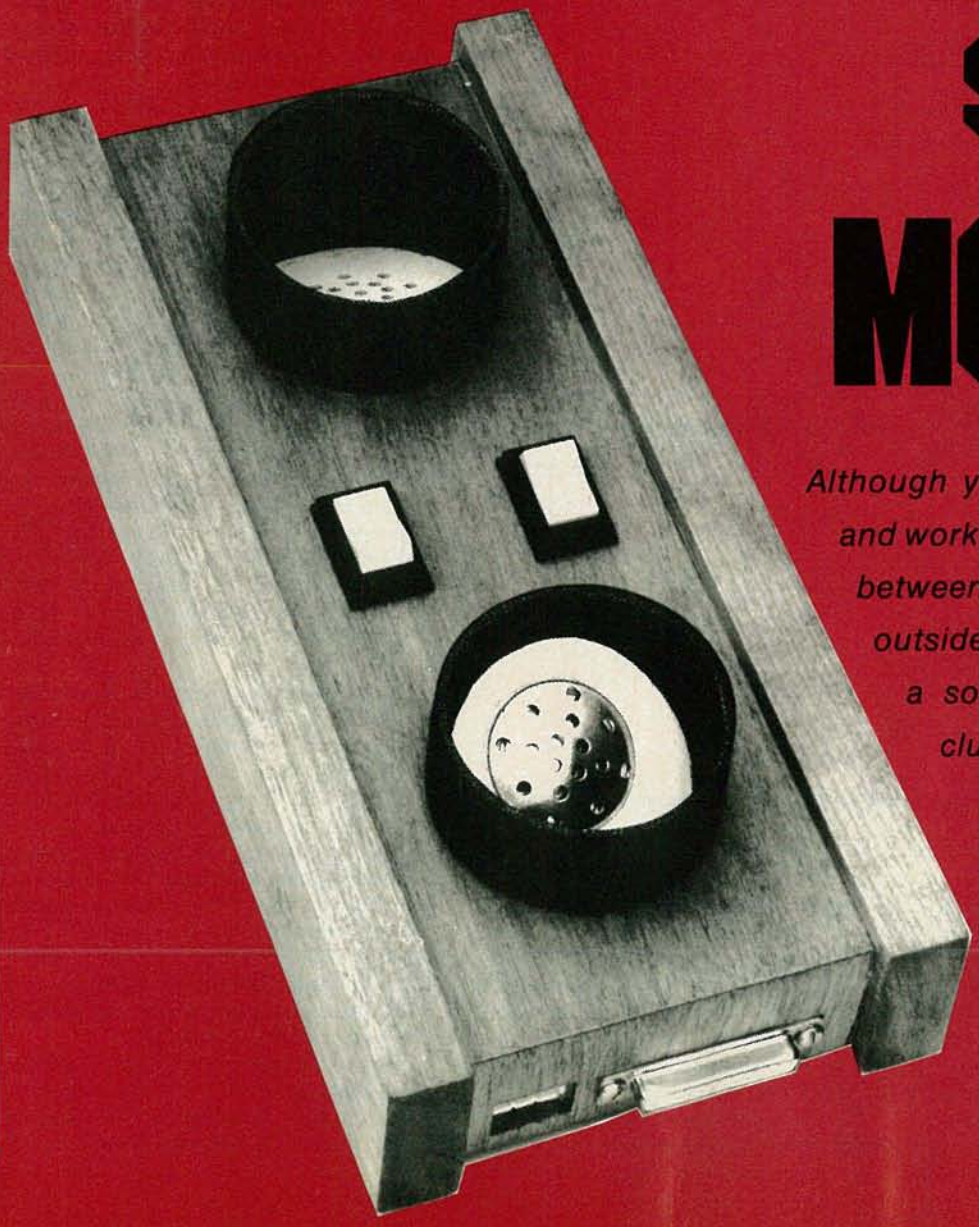
Here is a very simple terminal emulator. You should be able to fit this small software package into a corner of PROM if you wish. It is simple enough for most novices to be able to adapt it to their particular situations quickly. While by no means sophisticated, it is an excellent tool for becoming familiar with time-sharing systems and with the hardware and software treatment of serial communications. We will present it in machine language but most users will be able to program the same routines in BASIC.

The fundamental concern in the package is to use existing software whenever possible. Thus we assume that a command interpreter and parameter-parser (the parser evaluates an expression such as "n = a + b × c", determines what operations are to be performed in what sequence, and provides the proper instructions to the microprocessor) are available elsewhere in the system—for example in the operating system or the monitor. That not only shortens development time and eases the patching to machine-dependent I/O devices, it also allows the finished product to become an integrated part of the existing software. The user may simply issue a command rather than have to load a subsystem, transfer control to it, and then, finally, issue that command.

The terminal-emulator software uses nine two-letter commands. Eight of those, shown in the flowchart in Fig. 16, select various options. The ninth (see Fig. 17), invokes (calls into action) the emulator itself. A glossary is provided to clarify terms used in the description that follows that may not be familiar to you.

The baud rate is set by the command "SS *nnnn*" where "SS" instructs the software to set the baud rate and "*nnnn*" is a hex number corresponding to the divisor that will derive the correct baud rate from the baud-rate generator. The commands "S1" and "S2" select one or two stop-bit formats, respectively. The recognition character is set by the command "RC *n*" where "RC" tells the program that the recognition character is about to be set, and "*n*" is the hex value of that character. Odd or even parity is set by "PO" or "PE" and, finally, the echo source (remote or local) is set by "RE" or "LE."

These few commands may be more than you need. The baud rate, for instance, is probably already controllable by your hardware or software. The source



$60 MODEM

Although your modem is complete and working, one obstacle remains between your computer and the outside world—software! Here's a software package that includes everything your computer needs for serial communications.

ROBERT WARD

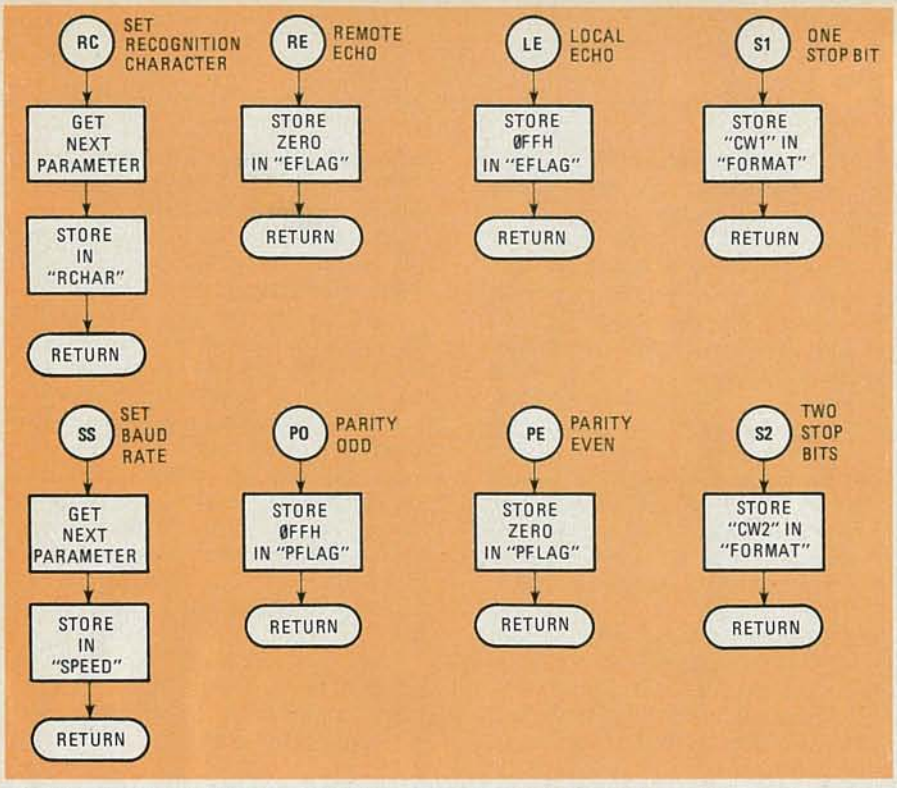


FIG. 16—EIGHT OF THE NINE two-letter commands used in the terminal emulator select the options.

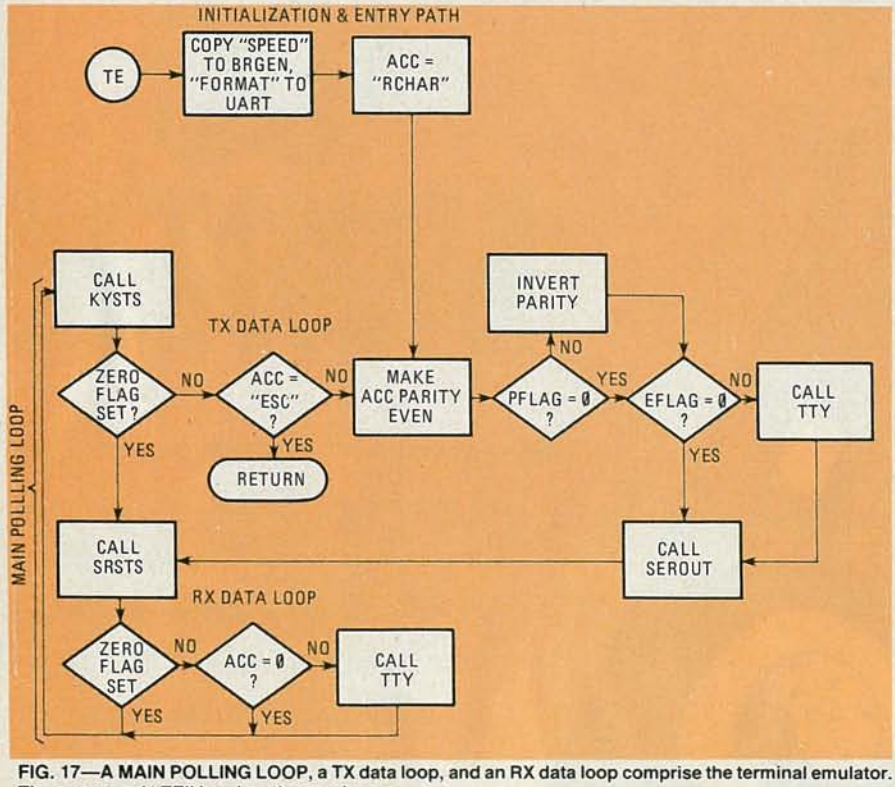


FIG. 17—A MAIN POLLING LOOP, a TX data loop, and an RX data loop comprise the terminal emulator. The command "TE" invokes the emulator.

of the echo may also be controllable, if not locally, then by issuing a command to the "answer" station. Most users will prefer to run at 300 baud all the time, which usually implies sending only one stop bit. Finally, we have never encountered an installation using odd parity. Thus you may want to set those options in the emulator permanently and implement only TE.

The terminal-emulator program supplied in assembly language in Table 2 should run on most 8080 and Z80 systems (ours uses an 8080). The program assumes that certain subroutines, or their equivalents, are included in your computer's monitor. Those subroutines are described in Table 3.

To eliminate some machine-dependence, and to illustrate a useful programming technique, parity is set by the software, rather than the UART, although most UART's are capable of performing this function themselves. We have included a test in the receive data-path to eliminate the nulls often sent as line-feed delays. That is a peculiarity necessary for the correct operation of our own teletype simulator. If you need that, you may also find that you need to expand it to test for and ignore other such characters, notably the ASCII "DEL" (7F hex).

In order to make the emulator as transparent to the user as possible, it retains control until the ASCII character "ESC" (1B hex) is typed. If you don't have that character on your keyboard, you will need to select a replacement. Choose it carefully. You want to avoid conflicts with other special-meaning characters, not only those used by your system, but also those used by the "answer" station.

The package is really just a collection of short subroutines to be called by your command interpreter. That means that the exact command syntax is determined by the command syntax you now use. You must avoid conflicts among the new commands and your existing command vocabulary.

Each command routine begins by pushing the command interpreter's starting address onto the stack. That allows a RETURN statement to send control back to the interpreter. Figure 18 shows a simplified flowchart of the typical interpreter to help you in understanding and identifying the routine involved. In that illustration, parameters are not parsed and assigned values until needed by the "action" routine.

The emulator shown in Fig. 17 may be broken down into five units. The main loop has only four steps. It polls first the keyboard and then the serial-input port. If data is available at either source, an appropriate service path (either RX DATA LOOP or TX DATA LOOP) is invoked. Those two paths are the two largest units in the routine. Finally there is a short exit path and an initialization-entry path.

In adapting those routines to your machine, the first step is to study the hardware. Get your manuals, find the data sheets on your UART and baud-rate generator IC's, and study the I/O drivers in your computer's software.

In investigating the baud-rate generator you must determine if it has a control register and, if so, how to select the appropriate mode of operation. You must learn the address of the control register and determine whether the baud-rate generator requires any initialization or clearing procedure.

You must identify the address of the baud-rate generator's data register. Most of those data registers will accept two bytes of data that may or may not be

TABLE 2

```
*
*  MANIFESTS USED THROUGHOUT THE PACKAGE
*
CW1       EQU   XX        INSERT THE VALUE WHICH
*                         SELECTS THE FOLLOWING
*                         FORMAT WHEN WRITTEN TO
*                         YOUR UART: 1 START BIT, 8
*                         DATA BITS, NO PARITY, 1
*                         STOP BIT.
CW2       EQU   XX        SAME AS ABOVE EXCEPT
*                         SELECTS 2 STOP BITS
STATUS    EQU   XX        THE SERIAL STATUS
*                         REGISTER'S ADDRESS
SCONT     EQU   XX        ADDRESS OF THE SERIAL
*                         CONTROL REGISTER
SIN       EQU   XX        ADDRESS OF THE SERIAL
*                         RECEIVED DATA REGISTER.
*                         ALL SERIAL REGISTERS ARE
*                         PROBABLY LOCATED IN A
*                         UART
BCONT     EQU   XX        INSERT ADDRESS OF YOUR
*                         BAUD RATE GENERATOR'S
*                         CONTROL REGISTER
BDATA     EQU   XX        INSERT ADDRESS OF YOUR
*                         BAUD RATE GENERATOR'S
*                         DATA REGISTER
BMODE     EQU   XX        MAY NOT BE NECESSARY.
*                         WITH 8253 FOR BAUD RATE
*                         GENERATOR, THIS VALUE
*                         SELECTS DESIRED MODE OF
*                         OPERATION
ESC       EQU   1BH       ASCII ESCAPE CHARACTER
NULL      EQU   Ø         LINE FEED DELAY
*                         CHARACTER
*
*  MEMORY ALLOCATION, DATA STRUCTURE DEFINITION
*
*
SPEED     DS    2         STORAGE FOR CURRENTLY
*                         SELECTED BAUD RATE
*                         DIVISOR
EFLAG     DS    1         SOFTWARE FLAG. ZERO INDI-
*                         CATES REMOTE ECHO.
PFLAG     DS    1         SOFTWARE FLAG. ZERO
*                         SELECTS EVEN PARITY.
RCHAR     DS    1         STORAGE FOR RECOGNITION
*                         CHARACTER
FORMAT    DS    1         STORAGE FOR SELECTED
*                         CONTROL WORD
*
*  INITIALIZATION OF THE UART AND BAUD RATE GENERATOR
*  ARE PERFORMED HERE. CONTROL TRANSFERRED TO TX
*  LOOP SO THAT RECOGNITION CHARACTER MAY BE SENT
*  BEFORE MAIN POLLING LOOP IS ENTERED.
*
*
NEWACT    MVI   A,BMODE   SELECT BAUD RATE GENER-
                          ATOR MODE
          OUT   BCONT     (8253 ONLY)
          LXI   H,SPEED   /
          MOV   A,M       /GET LSB OF DIVISOR
          OUT   BDATA     WRITE TO BRG DATA
                          REGISTER
          INC   H         /
          MOV   A,M       / GET MSB OF DIVISOR
          OUT   BDATA     WRITE TO BRG DATA
                          REGISTER
          LDA   FORMAT    /
          OUT   SCONT     / SET UP UART
          LDA   RCHAR     GET RECOGNITION
                          CHARACTER
          JMP   NA2A      TRANSMIT IT
*
*  THESE TWO INSTRUCTIONS ALONG WITH THE TWO AT NA2
*  CONSTITUTE THE MAIN POLLING LOOP
*
NA1       CALL  KYSTS
          JZ    NA2       SKIP TXLOOP IF NO DATA
*                         READY
*
*  THE FOLLOWING PATH TRANSMITS A BYTE OF DATA FROM
*  THE KEYBOARD
*
TXLOOP    CPI   ESC       /
          RZ              / CHECK FOR TERMINATION
                          REQUEST
NA2A      ORA   A         SET HARDWARE FLAGS
          JPE   NA3       /
          XRI   80H       / CREATE EVEN PARITY
NA3       MOV   B,A       SAVE DATA
          LDA   PFLAG     GET SOFTWARE FLAG
          ORA   A         SET HARDWARE FLAGS
          MOV   A,B       RETRIEVE DATA
          JZ    NA4       /
          XRI   80H       / CHANGE TO ODD PARITY IF
*                         DESIRED
NA4       MOV   B,A       SAVE DATA
          LDA   EFLAG     GET SOFTWARE ECHO FLAG
          ORA   A         SET HARDWARE FLAGS
          MOV   A,B       RETRIEVE DATA
          JZ    NA5       SKIP LOCAL ECHO
          CALL  TTY       PERFORM LOCAL ECHO
NA5       CALL  SROUT     SEND DATA
*
*  END OF TX LOOP. MORE MAIN POLLING LOOP.
*
NA2       CALL  SRSTS
*         JZ    NA1       SKIP RX LOOP IF NO DATA
*                         READY
*
*  THIS IS THE RX DATA LOOP
*
RXLOOP    CPI   NULL      YOU MAY NEED TO INSERT
*                         A SECOND TEST HERE IF YOU
*                         TALK TO INSTALLATIONS
*                         WHICH USE DIFFERENT LINE
*                         FEED DELAY CHARACTERS
          JZ    NA1       IGNORE LINE FEED DELAYS
          CALL  TTY       ECHO RECEIVED CHARACTER
          JMP   NA1       CONTINUE POLLING LOOP
*
*  THE FOLLOWING ROUTINES IMPLEMENT THE OPTION
*  SELECT COMMANDS
*
RC        CALL  PARAM     GET THE CHARACTER
*                         FROM INPUT BUFFER
          MOV   A,L
          STA   RCHAR
          RET
*
SS        CALL  PARAM     GET VALUE OF DIVISOR
*                         FROM INPUT BUFFER
          SHLD  SPEED
          RET
*
PE        XRA   A         ZERO PARITY FLAG
          STA   PFLAG
          RET
PO        XRA   A         SET PARITY FLAG NON-
*                         ZERO
          CMP   A
          STA   PFLAG
          RET
*
RE        XRA   A         ZERO ECHO FLAG
          STA   EFLAG
          RET
LE        XRA   A         SET ECHO FLAG NON-ZERO
          CMP   A
          STA   EFLAG
          RET
*
S1        MVI   A,CW1     LOAD ONE STOP BIT
*                         FORMAT WORD
```

(table concludes on next page)

TABLE 2 *(continued)*

```
        STA     FORMAT                          * 6850 ACIA
        RET                                     *
S2      MVI     A,CW2   LOAD TWO STOP BIT       *
*                       CONTROL WORD            SRSTS   IN      STATUS  THE ADDRESS OF THE
        STA     FORMAT                          *                       STATUS REGISTER
        RET                                             ANL     MASK    SELECT DATA READY BIT
*                                                       RZ
*                                                       IN      SIN     GET DATA
* THIS IS A SAMPLE INPUT ROUTINE, USED WITH MY          RET
```

written to the same address. You will also need to know which byte (least-or most-significant) should be written first. Also, find out if any special control word must be written to set up for the data-write.

Finally, you must know the frequency of the clock signal input to the baud-rate generator. Your baud rate will be determined by dividing that frequency by the number written to the baud-rate generator's data register.

Study the UART's control register until you understand how to select the transmission format specified in the listing in Table 2. You must know which bit of the UART's status register reflects "data ready" (and whether it is active high or active low—we assume active high in our routines). Again you will need the correct addresses for the control register, the status register, the "transmit data" register, and the "receive data" register. Note that there are sometimes separate status words for the transmit and receive status-registers.

Once you have collected that information, you are ready to write some "best guess" I/O drivers. Those are SRSTS, KYSTS, SROUT in Table 3. I suggest that until you are more familiar with the workings of serial communications you try to ignore error-and parity-checking. Don't get involved with them unless they're absolutely necessary to clear your UART.

When you have those routines written (see the end of Table 2 for a sample), set them up as an endless loop to test them. That will allow you to view the TX DATA output on a triggered scope. Similarly, a function generator may be used at the input to generate garbage to check the receive function. If you get a receive-indication constantly, even without an input signal, you have probably guessed wrong about the active state or position of the data-ready status flag.

Having mastered the above, you are ready to attempt to integrate the routines into your software. Your first task is to identify the command interpreter and parameter parser. The command table should be obvious because of its list of ASCII commands. A few monitors however, tokenize (translate into a kind of shorthand) their commands before looking them up. In that case the table is just more numbers. If you don't have an assembly-language listing, your user's manual—or a local computer club—may be able to help you.

The command interpreter can be found by following the program flow from the start. It will be one of the first routines encountered. A tipoff is that it almost always ends with the mnemonic PCHL.

To find the parameter parser, read through the action routines of commands that require an argument, "DUMP *nnnn*" (where "*nnnn*" is a memory address), for example. If a version of PARAM is not called in those action routines, then suspect that all parsing is done before the command is invoked. Go back to the code that fills the input buffer and trace its path. In that approach, the arguments will be valued and stored in fixed memory locations immediately after the input buffer is filled. If you can spot the memory locations, you can simply load the values you need directly from them instead of calling PARAM.

(continued on page 77)

TABLE 3

COMMAND INTERPRETER—This routine collects lines of input of the form 'COMMAND *parameter parameter....parameter.*' It identifies the command portion and compares it to a table of valid commands. If a match is found in the table, control is transferred to a routine located at an address retrieved from the appropriate table entry. Before the transfer of control, the command interpreter inserts its own address on the top of the stack so that the selected action routine may be exited with a normal return.

PARAM—This routine returns the value of the next command line parameter in the HL registers. Recognizes both hexadecimal numbers and ASCII literals.

TTY—This is the local output device driver. In this package it simulates a teletype on a CRT. Requirements are that it accept its input in the accumulator and that the data remain in the accumulator at exit.

KYSTS—Local input routine. Checks the status of the keyboard. On "data ready" condition, returns the data in the accumulator with the zero flag cleared. On "data not ready", returns with zero-flag set.

SRSTS—Local serial-input routine. Checks the UART status register for a "data ready" indication. Like the above routine, any received data is returned in the accumulator with the zero-flag cleared. When there is no data ready, return is with the zero-flag set.

SROUT—Local serial-output routine. This routine outputs the contents of the accumulator to the serial port. Contents of the accumulator are unchanged at exit.

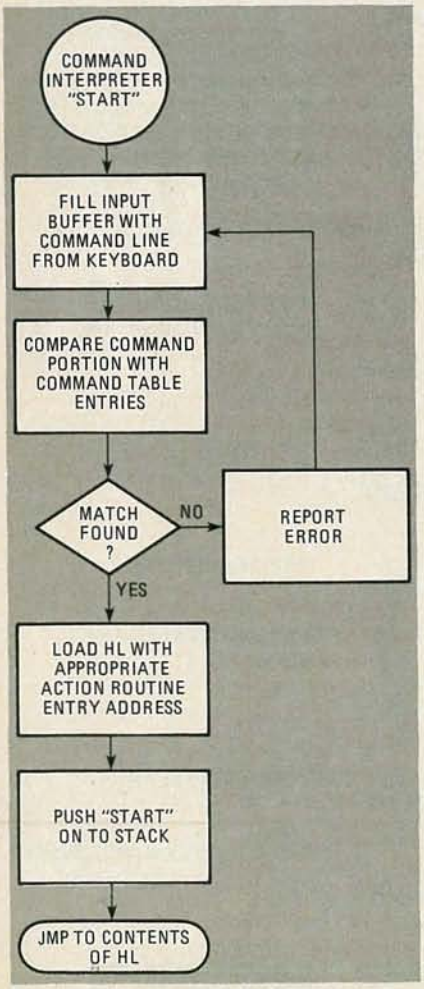
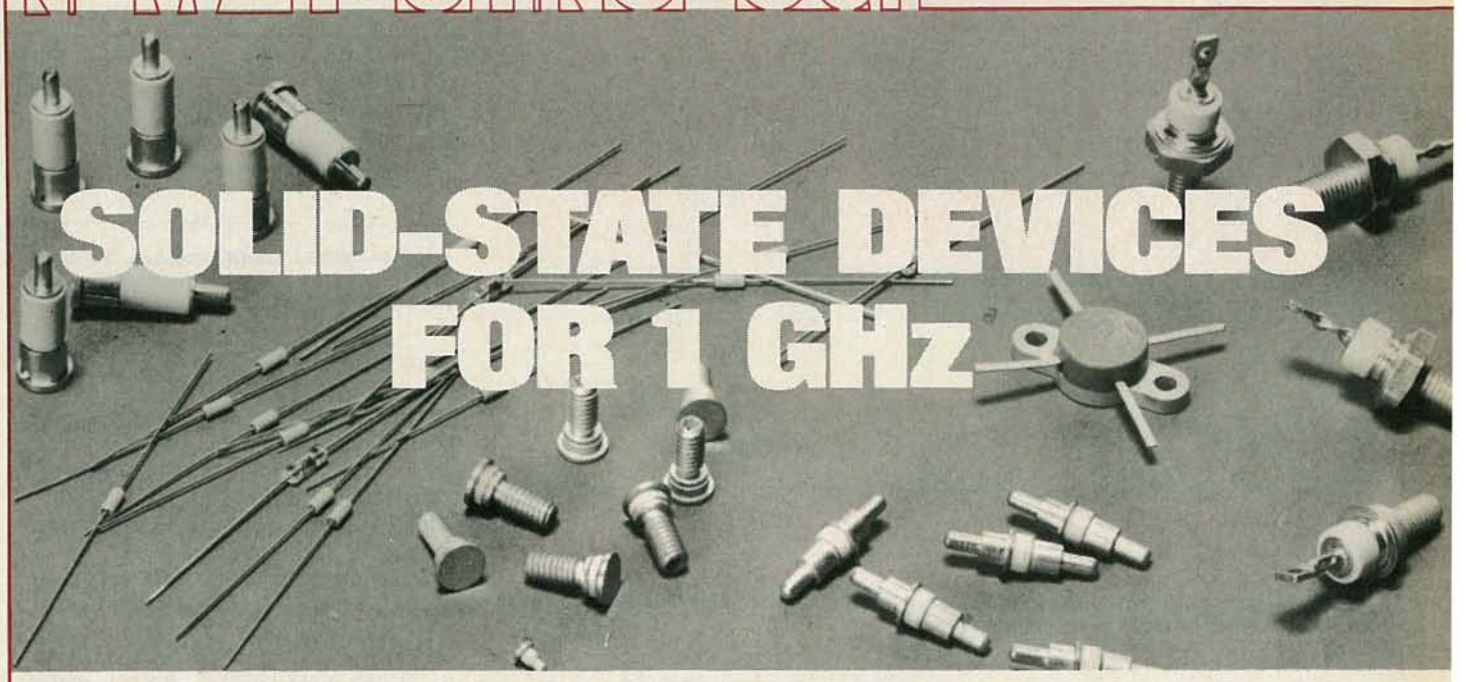


FIG. 18—PARAMETERS ARE NOT PARSED and assigned values until needed by the "action routine" in this command interpreter.



SOLID-STATE DEVICES FOR 1 GHz

New frontier for experiments. Solid-state devices let you explore the 1 GHz region and beyond.

JOSEPH J. CARR

Part 2 USING SOLID-STATE DEvices to generate microwave signals required solving some complex problems. This month we'll continue our look at the development of those devices.

Gunn oscillators

The Gunn device will oscillate in the transit-time mode using only a simple resistance for the load. The efficiency in that mode, however, is only one- to five-percent, so relatively large amounts of DC power are required to generate small amounts of RF power.

If we place the Gunn device inside a resonant cavity, and bias the device for the delayed transit-time mode, then we will obtain better efficiency and some flexibility of the operating frequency.

Figures 8 and 9 show two methods for mounting a Gunn device inside a resonant cavity. Figure 8 shows a cutaway view of a coaxial cavity. The cavity is one-half of a wavelength long, while the base of the Gunn device is placed at the one-eighth wavelength point. A conductive "dowel" supports the Gunn device and connects it to the ends of the cavity; the dowel is also the center conductor of the coaxial cavity.

A tuning screw is used to vary the operating frequency of the device. It effectively changes the dimensions of the cavity, and can fine tune the operating frequency over a small range.

The oscillations on the inside of the cavity are coupled to the outside world through a short coupling loop that is situated parallel to the dowel center conductor. The load impedance of the Gunn device is set by the position of the coupling loop, and is adjusted for the best compromise between the stability of the operating frequency and the maximum output power.

While simple, the coaxial cavity suffers from a few basic problems. It is a low-Q tank, and is sensitive to factors such as temperature and load impedance variations. The Gunn device in a coaxial cavity may also tend to oscillate on a harmonic of the tank frequency.

A rectangular waveguide can also be used as a tuned cavity if one end is blocked off and the Gunn device is placed at the one-eighth wavelength point as shown in Fig. 9. The DC bias is provided to the Gunn device through an RF choke that is designed to block the microwave RF.

The dimensions of the cavity are determined by the placement of a partition. Energy from the cavity is coupled into the waveguide-transmission line through an opening called an *iris*. The size of that iris is a trade-off between

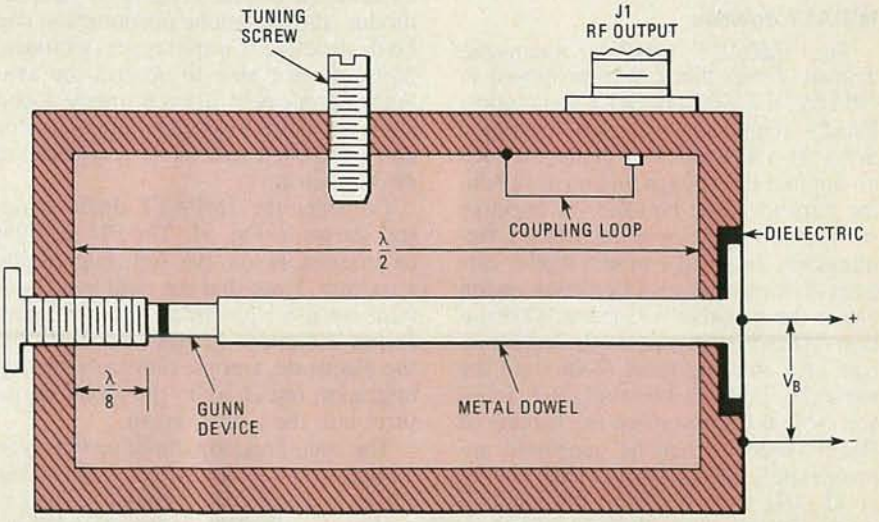


FIG. 8—CUTAWAY VIEW of a coaxial cavity. The cavity is half a wavelength long and the base of the Gunn device is placed at the one-eighth-wavelength point.

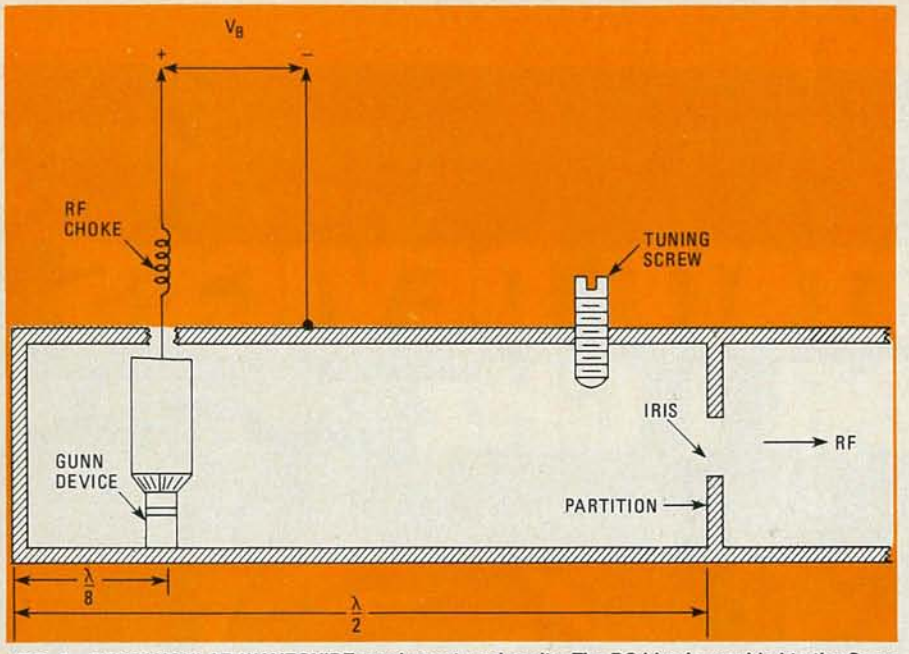


FIG. 9—RECTANGULAR WAVEGUIDE used as a tuned cavity. The DC bias is provided to the Gunn device through an RF choke designed for microwave use.

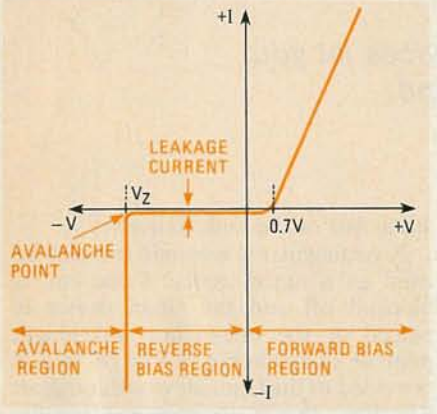


FIG. 10—THE CURRENT-VERSUS-VOLTAGE curve for a PN junction diode. Note the high reverse current when the voltage exceeds the avalanche point, V_Z.

maximum output power and a sensitivity to changes in the load and internal impedances of the Gunn device.

IMPATT devices

The IMPATT (*IMP*act *A*valanche *T*ransit *T*ime) diode was proposed in 1953 by W.T. Read of Bell Laboratories. Read's suggestion was that the phase delay in a PN junction diode between an applied RF voltage and an avalanching current could be used for negative resistance operation at microwave frequencies. In Read's model diode, carriers drifting through a depletion region cause the negative resistance. Fabrication difficulties prevented the construction of a working Read diode until the mid-60's. In 1965, however, R.J. Johnson of Bell Labs verified the validity of Read's model when he generated approximately 80 milliwatts of RF energy at 12 GHz from a silicon PN junction diode. Read's diode depends upon impact avalanche and transit-time phenomena, so was given the acronym IMPATT. It has now been recognized that Read's structure is just one of several that will result in IMPATT operation.

Figure 10 shows the current-vs-voltage curve for a PN-junction diode. For our present purposes we will consider only operation in the reverse-bias region, i.e., the region in which V is less than zero. There is a critical breakdown voltage V_Z in the reverse bias region. At reverse potentials less than this value, the current through the PN junction is a very small leakage current. But the current suddenly increases when the voltage exceeds V_Z: the junction is operating in avalanche. The increased current is due to secondary emission or avalanche multiplication, in which electrons of the leakage current have a high probability of colliding with other electrons. The result is a very rapid increase in reverse current. In ordinary signal or rectifier diodes, the avalanche phenomenon can be destructive. Certain types of diodes, however, are able to control the avalanche process by using properly doped semiconductor material. Zener diodes and controlled avalanche rectifiers are in that category.

Consider the IMPATT diode structue shown in Fig. 11. The PN junction of interest is on the left side of the structure. Note that the right hand contains an n-n$^+$ junction. The n$^+$ region forms a contact of low resistivity for the electrode, and prevents metallic ion migration (much as in the Gunn structure) into the active region.

The center region is made up of n-type material and is the active zone. That active region must be doped to the extent that it is fully depleted at breakdown. We want to insure that a very small electrical field will cause velocity saturation of the electrons.

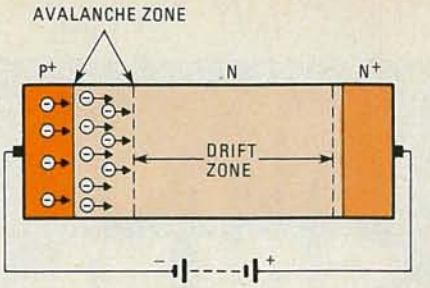


FIG. 11—IMPATT DIODE structure. Electrons generated in the avalanche zone will flow into the drift zone of the n-region.

The electrons generated in the avalanche zone of the IMPATT diode shown in Fig. 11 will flow into the drift zone of the n-region. It takes very little added voltage to cause a large increase in current in that mode.

Let's consider a situation where an IMPATT device is biased to a potential just below V_Z; i.e., in the reverse-bias region but not quite to the avalanche point. We must select such a bias that a small added potential will throw the device into the avalanche region. Let us further assume that the IMPATT device is operated in parallel with a high-Q resonant tank circuit (i.e., the IMPATT device is operated inside of a resonant cavity). The reverse-biased PN junction will create a noise signal that shock-excites the tank circuit into oscillation. The RF voltage produced by the resonant tank is added to the bias voltage, causing the diode to go into the avalanche mode on positive peaks of the cycle.

The number of electrons generated by avalanche multiplication is a function of the applied voltage (Fig. 12-a) and the number of charge carriers present. Because of that dual dependence, the avalanche current pulse (Fig. 12-b) continues to increase even after the RF voltage cycle has passed its peak. During that process the charge density at the avalanche point grows exponentially while the avalanche charge current (Fig. 12-c) drifts toward the other end of the drift zone.

Does the IMPATT produce negative resistance? Note that the current reaches a peak (Fig. 12-c) as the sine-wave RF voltage goes through its zero crossing point (Fig. 12-a); a 90-degree delay with respect to the voltage peak. The criterion for negative resistance is a phase difference of 90 degrees or more between the applied voltage and the series current, so we may conclude that the IMPATT is a negative-resistance device.

The pulse current in the external tank circuit (Fig. 12-d) is semi-square and represents a current lag over applied voltage of more than 90 degrees. Those two factors are shown together in Fig.

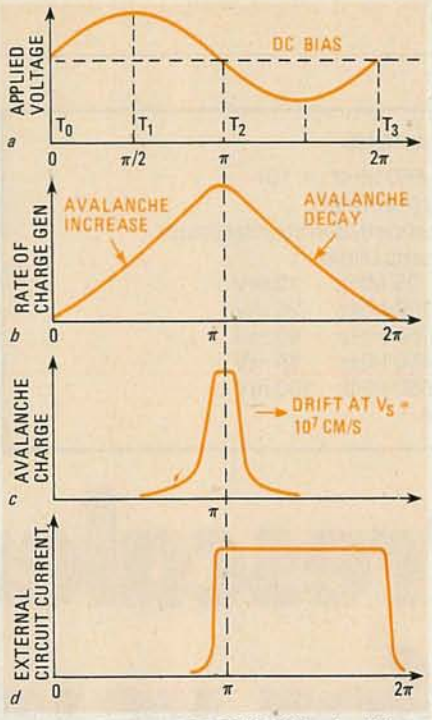


FIG. 12—AVALANCHE CURRENT pulse (*b*) continues to increase even after the RF voltage cycle has reached its peak (*a*).

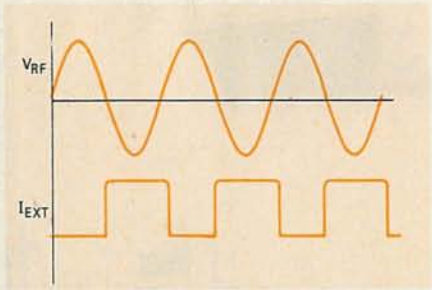


FIG. 13—THE PULSE CURRENT in the external tank circuit is a semi-squarewave and lags the applied voltage by more than 90 degrees.

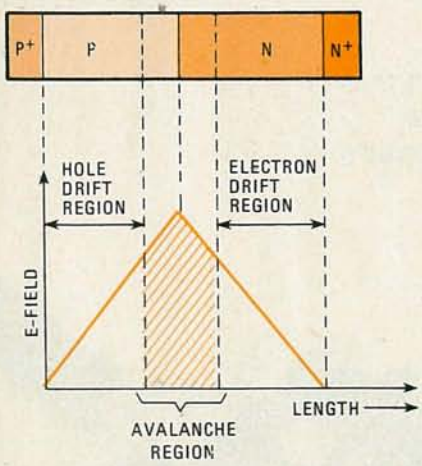


FIG. 14—DOUBLE-DRIFT IMPATT device. In this device the avalanche region brackets the PN junction.

13. Two factors combine to cause the positive external current during the negative excursions of the RF waveform: the time delay of the avalanche process and the drift time of the avalanche charge. Instead of absorbing energy, in the manner of a positive, or ohmric, resistance, the IMPATT offers a negative resistance.

The IMPATT device just described is known as a *single-drift* device. But an avalanching PN junction produces both kinds of charge carriers; i.e., holes and electrons. The single-drift IMPATT uses only the electrons, and returns the holes to the cathode p-region. That fact limits the efficiency of the single-drift devices to less than 15 percent.

Greater efficiency is obtained through the use of a *double-drift* IMPATT device, such as shown in Fig. 14. That is a p^+-p-n-n^+ structure in which the avalanche region brackets the PN junction. The p^+ zone serves as an ohmic contact for hole charge-carriers, while the n^+ region serves the same purpose for electrons. The output efficiency is increased over that of the single-drift variety because the holes drift across the p-zone very nearly in phase with the electrons drifting across the n-zone.

IMPATT applications

The previous discussion has demonstrated that the IMPATT device will function as an oscillator at microwave frequencies. If an IMPATT is placed inside of a high-Q resonant cavity, and biased with a DC potential slightly below the avalanche potential, then noise pulses will ring the cavity to produce the RF sinewave that actually drives the junction into the IMPATT mode of oscillation. IMPATT operation occurs because the voltage of the ringing waveform (an RF signal) adds algebraically with the DC bias, causing the junction to go into the avalanche mode on peaks of the RF cycle. If the device is correctly biased, then, the junction will be in the avalanche condition for most of the positive half of the RF sinewave excursion.

Although the IMPATT device is an oscillator that is capable of producing substantial peak-pulse powers at microwave frequencies, it is not universally applied because it is a noisy source (avalanching is a noisy process). For that reason, one does not ordinarily see IMPATT's as receiver local oscillators.

IMPATT's are used primarily at frequencies above 3 or 4 GHz, with frequencies up to 100 GHz having been obtained. Many high-power IMPATT's require operating potentials between 75 and 150 volts DC; a fact seen as a disadvantage by some. Also, IMPATT's are usually operated from constant-current power supplies, also a disadvantage.

The applications of the IMPATT are not limited to oscillator service. There is one report of IMPATT's being used as microwave frequency multipliers. Many IMPATT's are used as amplifiers. In fact, it has been claimed that most IMPATT applications are as amplifiers, not as oscillators. IMPATT amplifiers have only one port, so must be coupled to a *circulator* to isolate input and output ports of the amplifier as shown in Fig. 15. That type of amplifier is called a *reflection amplifier*.

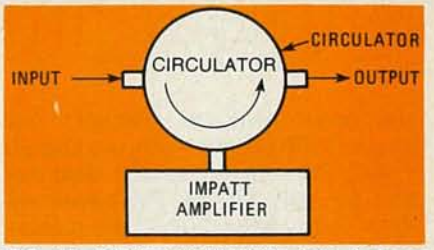


FIG. 15—IMPATT AMPLIFIERS have just one port and must be coupled to a circulator.

TRAPATT diodes

IMPATT diodes are generally limited to operation at frequencies above 3 or 4 GHz. The problem of lower operating frequencies is one of finding a method for stretching the duration of the transit time. Until 1967, it had proven difficult to use solid-state devices to generate any significant amount of power in the 1-GHz region. In 1967, however, engineers working for RCA succeeded in exciting an IMPATT-like device into a different mode of operation. One set of trials produced pulse powers of 425 watts with an efficiency of 25 percent. Further work with that new mode yielded efficiencies up to 60 percent, with later work producing efficiencies as high as 75 percent. Tuned tank circuits developed at RCA in that era permitted a tuning range that was continuous over 0.9 to 1.5 GHz.

It appeared that the problem of increasing the transit time had been solved, but no one really knew why! At the time the basic work on the TRAPATT device was going on there was no good theory that explained the observed behavior. Workers at RCA dubbed the new mode the *anomalous mode,* perhaps reflecting the fact that they had no theory of operation.

At least two different theories were advanced to explain the behavior of the anomalous mode. Bell Laboratories advanced the theory that the high efficiency and lowered frequency of operation was explained by the fact that a trapped plasma was created in the device between sweeps of the IMPATT mode of operation. The theory held that the trapped plasma shielded the charge carriers from the external voltage field, causing them to drift out of the plasma at low velocity. That theory led to the acronym by which the device is now known: TRAPATT (*TRA*pped *P*lasma *A*valanche *T*ransit *T*ime).

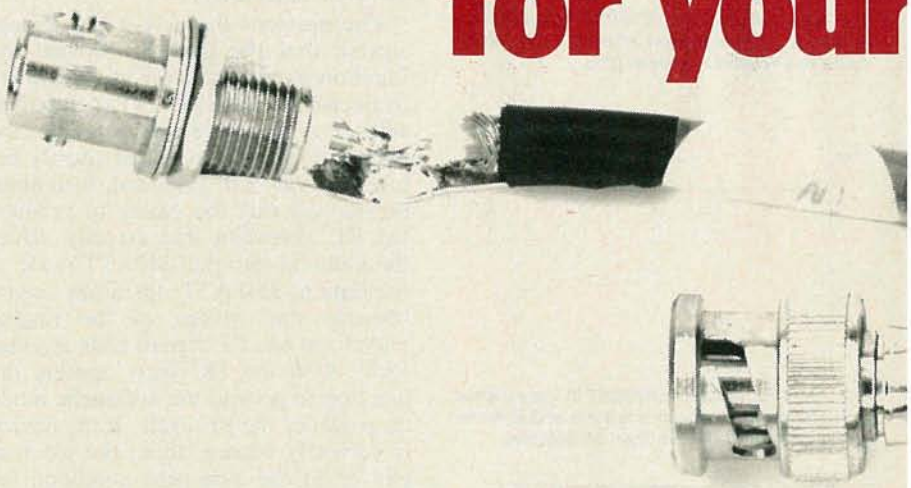
Next month we'll finish discussing the TRAPITT diode and show you how it and the IMPATT are related. We'll conclude this three-part series with a look at the BARITT device. **R-E**

UHF Prescaler for your

Your old, slow, frequency counter isn't obsolete. Build this inexpensive prescaler and extend your counter's range as high as 650 MHz.

SPECIFICATIONS

Frequency range: 25 MHz-650 MHz (÷ 10)
Input impedance: 50 ohms (nominal)
Input protection: diode-clamped, 5-volts maximum
Output signal level: TTL-compatible
Input sensitivity (typical): 25 MHz 10 mV
150 MHz 25 mV
250 MHz 50 mV
450 MHz 75 mV
600 MHz 100 mV
Supply: 5 VDC, 50 to 75 mA



YOU DON'T HAVE TO REPLACE YOUR present VHF counter—you can upgrade it with the simple prescaler described here for only $30.00. The circuit will allow you to extend the useful range of your frequency counter 10 times, to a maximum frequency of 650 MHz. A 45-MHz counter can now go up to 450 MHz and a 60-MHz counter will measure frequencies up to 600 MHz. With an updated UHF counter you will be able to check synthesized TV receivers and 2-meter amateur and commercial transmitters, as well as marine and 450-MHz communications equipment.

The small 1 × 2-inch PC board contains a high-speed ECL (*E*mitter *C*oupled *L*ogic) prescaler IC and a single-stage common-emitter amplifier. Its small size will allow it to fit inside most frequency-counter cabinets. The circuit requires 5-volts DC at 50-75 mA. The prescaler can also be installed in a separate enclosure with its own power supply and used without any modification being made to the counter.

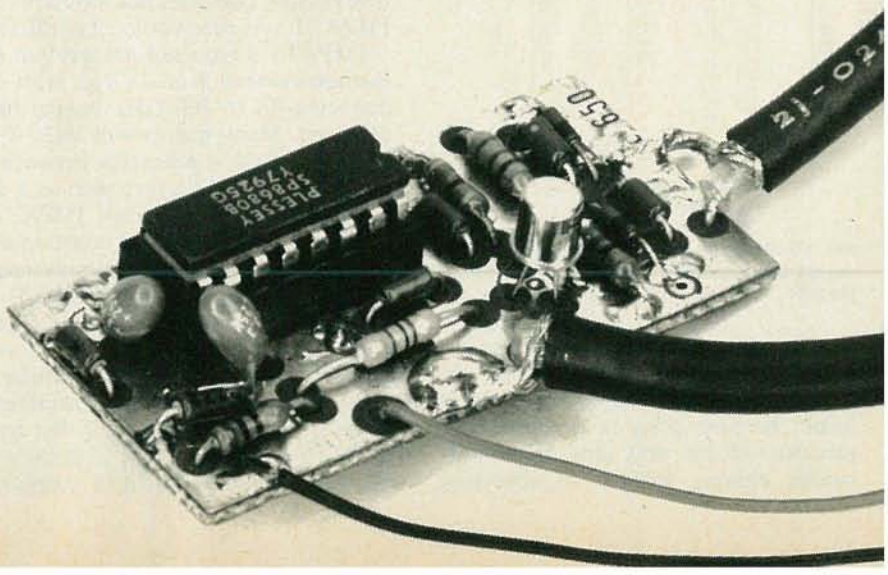
Theory of operation

The prescaler circuit (Fig. 1) works by amplifying the input signal to a level where it can be divided by the prescaler IC. The output signal from this IC will be exactly one-tenth the frequency of the input signal. There is no accuracy specification. The prescaler always divides exactly by 10. If the input signal is 450 MHz, then the prescale output-signal will be 45 MHz. Of course, the frequency counter does not know that you have prescaled the input signal so you will have to make allowances for the decimal point being in the wrong place. (The correct decimal-point position is one place to the right.) It may be possible to modify the frequency counter by using a two-pole switch that both applies power to the prescaler and shifts the decimal point one place to the right.

The PC board has a ground plane on the component side. Grounding is critical at UHF frequencies and this ground plane provides a very short path to ground. Any component lead going to ground is simply soldered to the ground plane on that side of the board.

Construction

Foil patterns for both sides of the board are provided in Figs. 2 and 3, and a parts-placement diagram, as seen from the component (ground plane) side of the board is shown in Fig. 4. The positive leads are marked by a dot or stripe on the bodies of tantalum capacitors C4 and C5 and they must be placed through the holes that are not part of the ground plane on the component side of the board. The negative leads of C4 and C5 get soldered to pads on the circuit side of



the PC board as well as to the ground plane. (*Any* component lead that intersects the ground plane should be soldered to it.) There is a hole adjacent to C3 and R2 where a piece of excess component lead is to be placed and soldered to both sides of the PC board. That feedthrough wire provides the ground for pins 12, 13, and 14 of the prescaler IC. There is also a hole next to pin 1 of IC1 that needs a similar feedthrough wire.

The 5-volt ground, input, and output connections are shown along the lower edge and side of the PC board in Fig. 4. The signal input should be made through coaxial cable such as RG-174/U. The shield of the coax should be soldered to the prescaler PC-board ground plane and to the ground lug of the counter's RF-input connector.

Frequency Counter

BILL OWEN

Connection and use

The available space and internal layout will determine the best way to modify the counter for the prescaler. Several possible interfacing schemes are shown in Figs. 5 through 8. It will be helpful for you to have a schematic of your counter so you can determine where the signal exits its amplifier and enters the logic and counting circuitry. A DPDT switch can usually be mounted on the counter's front or rear panel and used to switch the counter's input connector to the prescaler's input, or a second input connector (preferably a UG-1094/U BNC-type with solder lug) can be added.

Figure 5 shows the simplest connection scheme, requiring no modification to the counter. The circuit in Fig. 6 shows the addition of a DPDT switch to permit the counter's input connector to be used by either the counter or the prescaler. The one in Fig. 7 allows you to bypass the counter's amplifier and couple the prescaler's output directly to the counter's logic- and counting-circuitry. The arrangement in Fig. 8 will work the best, but requires the addition of a switch and a second input connector along with some knowledge of the

PARTS LIST

All resistors 5%, ¼ watt
R1—10 ohms
R2—100 ohms
R3—47 ohms
R4—75 ohms
R5—220 ohms
Capacitors
C1-C3, C6-C8—820 pF, monolithic
C4, C5—3.3. μF, 25-volt, tantalum
Semiconductors
D1, D2—1N914
Q1—2N2857 high-frequency, NPN-type
IC1—650-MHz prescaler (Plessey SP 8680 or Fairchild 11C90)
S1*—DPDT switch
Miscellaneous: PC board, 16-pin IC socket, coax, BNC connectors*, solder, etc.

Note: Need for items marked with "*" depends on user's requirements (see text).

The following are available from Optoelectronics, Inc., 5821 N.E. 142nd Ave., Ft. Lauderdale, FL 33334, Tel. 800-327-5912 (orders only), 305-771-2051:
Kit of all parts (PSL-650 Kit), $29.95
Double-sided PC board (PSL-650 Board), $6.95
Counter probe (P-100), $13.95
Telescoping antenna w/right-angle BNC connector (TA-100), $9.95
SP8680 or 11C90 IC, $16.95
2N2857 transistor, $2.95
Minimum order $15.00—if less, add $2.00 for special handling. Please include 5% of total order for shipping, handling and insurance. COD $2.00 additional. Florida residents please add 4% tax. Visa and Mastercard accepted.

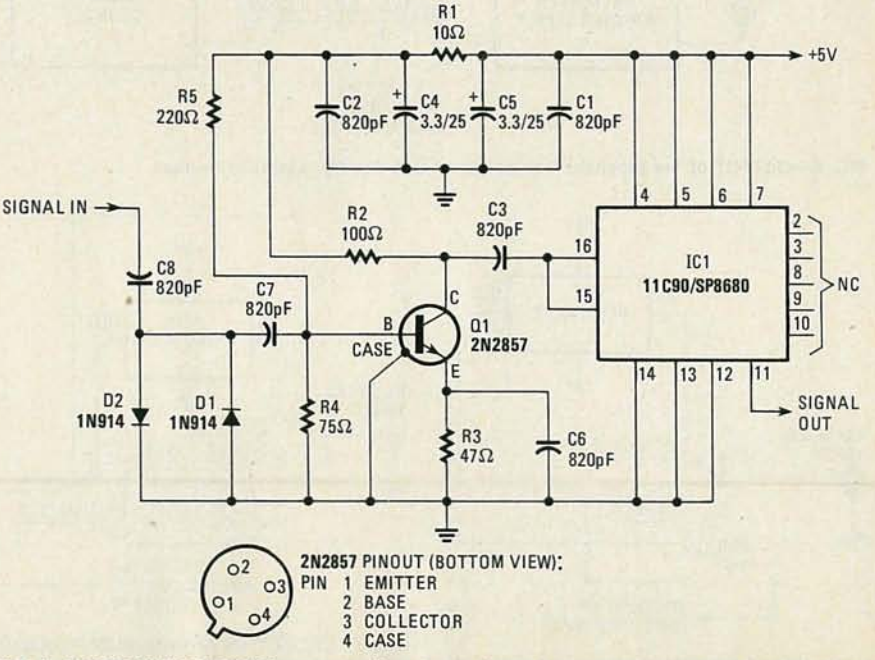


FIG. 1—PRESCALER CIRCUIT is not complicated. Not shown here are connectors and switch, since those will vary according to needs of user.

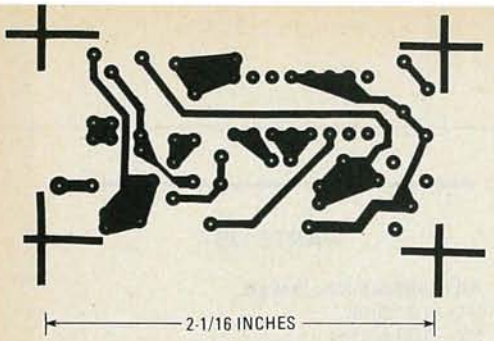
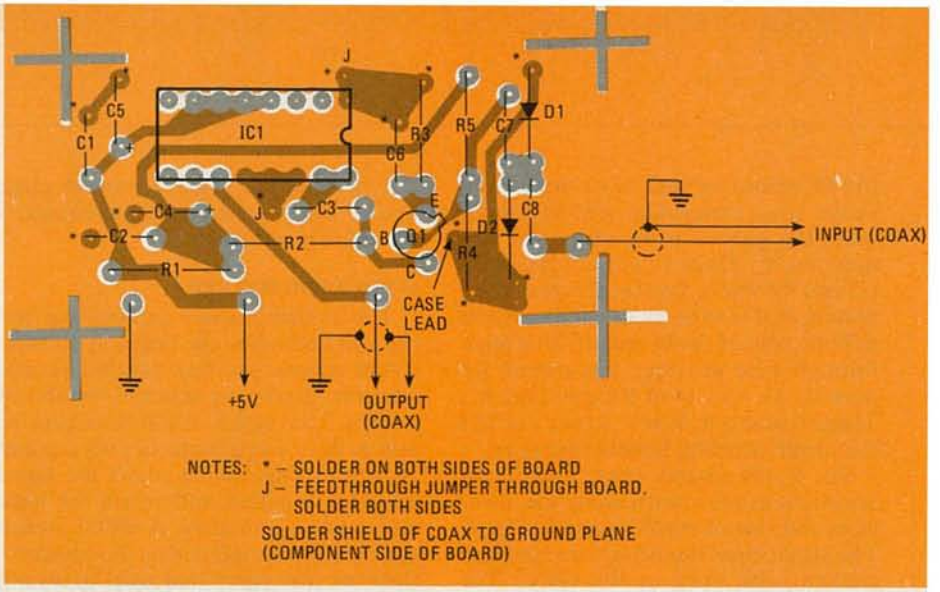
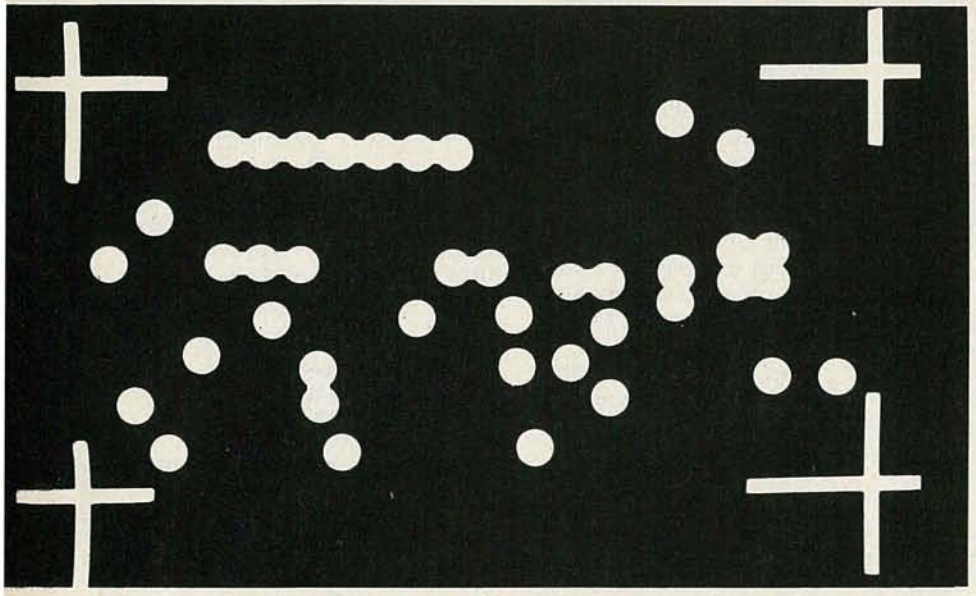


FIG. 2 (ABOVE)—BOTTOM of the double-sided PC board. Many of the IC's pins are not connected to anything.

FIG. 4 (RIGHT)—SHIELD OF COAXIAL CABLES is soldered directly to ground plane, as is "case" lead of 2N2857 transistor.

FIG. 3 (BELOW)—GROUND PLANE on component side keeps lead-lengths short, as required at UHF frequencies.





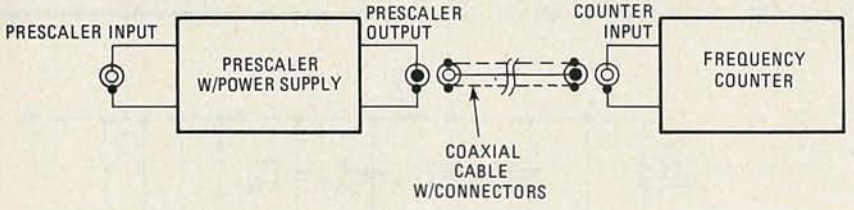


FIG. 5—OUTPUT of the prescaler can be connected directly to input of counter.

counter's circuitry. The switched 5-volts in Fig. 8 can be used to shift or eliminate a decimal point, as well as to conserve power when the prescaler is not being used.

If you wish, the PC board can be mounted inside the counter's cabinet with double-sided foam tape.

The use of a 10- or 15-ohm resistor (R1) in series with the prescaler's 5-volt input reduces power consumption, as well as improving sensitivity.

Signals from signal generators, frequency synthesizers, and other types of oscillators can be direct-coupled to the prescaler's input. Transmitters must never be direct-coupled to the prescaler input or damage may result from overload.

A length of RG-58/U coax with a BNC connector on one end and mini-alligator clips on the other end can be used as a direct-coupled probe. For measuring transmitted RF frequencies an antenna can be attached to the prescaler's input connector. A stiff piece of wire can be used, or a telescoping antenna with a built-in right angle BNC connector. By using an antenna, transmitted RF power-levels from less than a watt to several thousand watts can be handled easily, without damaging the counter. **R-E**

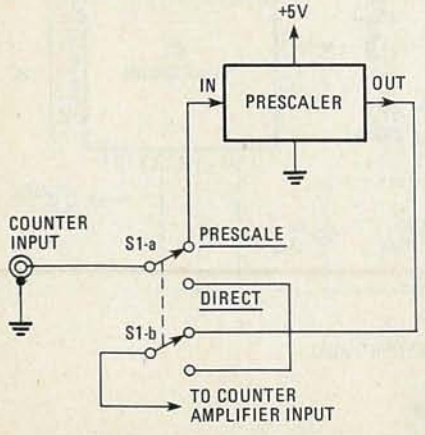


FIG. 6—DPDT SWITCH directs signal either to prescaler or to counter's amplifier input.

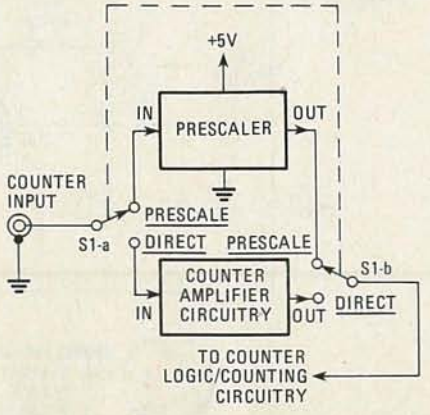


FIG. 7—USING THIS ARRANGEMENT, outputs of prescaler and counter's amplifier are applied directly to counter's logic/counting circuits.

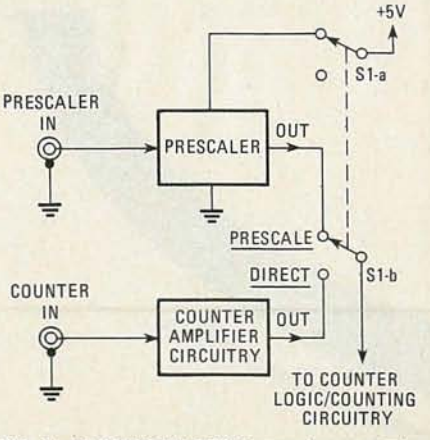


FIG. 8—PREFERRED SETUP uses two separate inputs. Switched 5-volts turns prescaler on and off and can also be used to move decimal point (see text).

Digital Audio using your VCR

LEONARD FELDMAN
CONTRIBUTING HI-FI EDITOR

Existing video-cassette recorders can be adapted for use in digital audio applications. Here are some details of the EIAJ standard for home-use PCM encoders and decoders.

WHILE THE AUDIO INDUSTRY SEEMS slated for a long-drawn-out debate as to which type of disc format is best suited for digital audio-reproduction (at least a half dozen video/audio and audio-only digital disc schemes have been proposed and demonstrated successfully), when it comes to storing audio information in digital form on tape, there is at least some stability.

Fortunately for the future of digital audio, a group of Japanese manufacturers, all members of the EIAJ (*E*lectronic *I*ndustry *A*ssociation of *J*apan) realized that unless they could agree on standards for taping digital audio information, the new technology might well go the way of quadriphonic sound. where too many competing systems resulted in public disenchantment. Accordingly, the EIAJ (whose membership includes just about every manufacturer involved in digital audio and VCR manufacturing) was able to come up with a set of standards that they have labelled EIAJ Technical File STC-007, *Home Use PCM Encoders and Decoders*. PCM, of course, stands for *P*ulse *C*ode *M*odulation and is just another way of saying digital audio.

The PCM processor

For those unfamiliar with the way that digital audio recording works, a brief review might be in order. A PCM (or digital audio-processor) is an electronic component that converts an analog (continuous) signal into a number-code consisting of millions of pulses per second. Each number (or "word"), expressed in binary form, represents a sampled amplitude of the analog waveform. In that digitized form, the description of the waveform can be stored on tape (or, for that matter, on discs), providing that the bandwidth-capability of the storage medium is adequate. In playback, the function of the PCM processor is reversed. The millions of pulses, fed back to the processor as they are read from the tape, are reconverted into an analog electrical signal that is then fed to the usual stereo amplifier and speaker pair.

The ideal storage device for such dense digital information is the home VCR, first because it can handle bandwidths to beyond 3.5 MHz, and second, because there are already many of those products in consumers' hands, with more being bought every day. Those familiar with how a VCR works, (and familiar with the requirements of the U.S.-type NTSC video signal), will appreciate the difficulties that had to be overcome to use a VCR as a tape-storage device for digitally processed audio information.

Since the VCR's recording format was designed originally for video, that means that if we are going to use a standard VCR as a storage device for digital audio recording, we have to fit the millions of "bits" that constitute the digital-audio code into the video signal-format that is already part of every VCR. That format includes horizontal-sync pulses after every video line, and vertical-sync pulses after every video field. There are 30 interleaved frames (60 fields) per second and 525 horizontal lines per frame in the NTSC TV-standard. That means that you can't record those digital audio "bits" onto the videotape in one continuous stream. The pulses have to be added to the signal format during the horizontal-line periods of the normal video-picture format. Since there are many ways that this can be done, it was important that the industry get together on a standard format for PCM/VCR interface and use.

The standard set forth by the EIAJ does not tell manufacturers how they must build their PCM audio processors, or what features such products must have. Rather, it describes the signal that is to be recorded on the VCR's

tape cassette in sufficient detail so that a recording made on one VCR would be playable on another VCR, using another PCM processor (providing, of course, that the VCR formats were the same).

The EIAJ PCM standardized format

Two channels are used in the new standard (for stereo). Pre-emphasis (with automatically sensed de-emphasis during playback) for additional noise reduction is optional. The noise-reduction system uses two time-constants: 50 microseconds and 15 microseconds, as shown in Fig. 1. The sampling frequency (the rate at which the analog signal is

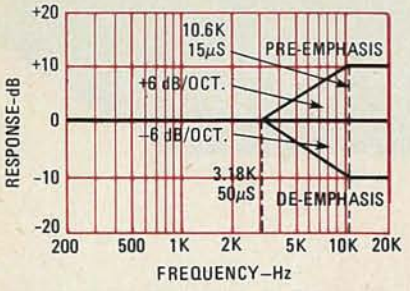


FIG. 1—NOISE-REDUCTION SYSTEM uses two time constants for pre-emphasis and automatically sensed de-emphasis.

sampled for instantaneous "numerical" amplitude) has been fixed at 44,056 Hz. That rather unusual number is more than adequate for recording and reproducing audio signals up to 20 kHz (the sampling rate in digital audio must be at least twice the highest frequency to be recorded) and in addition, it bears a mathematical relationship to the horizontal TV line-rate.

The EIAJ system uses 14-bit linear encoding. This means that the encoder can assign any one of 16,384 ($2^{13} + 2$) values to each sampled amplitude; and, mathematically, that means that for home PCM recorders and processors we can expect a dynamic range of about 85 dB. Some of the encoders already demonstrated do not actually use 14-bit encoding but instead, for reasons of economy, use 12-bit encoders with so-called floating-point converters that give the equivalent of a 14-bit output. It is the cost of this section of the PCM processor that accounts for the very high price of those products so far. We can hope that when A/D and D/A converters are reduced to large-scale-integration IC's and are produced in high quantities we may begin to see lower costs for those PCM processors.

The total number of bits per second in the standard is 2.643 megabits. That number was determined in part by the need to have enough redundancy for error correction and horizontal blanking. As shown in Fig. 2, the contents of one horizontal line of equivalent video-format signal will consist of three words each from the left- and right-

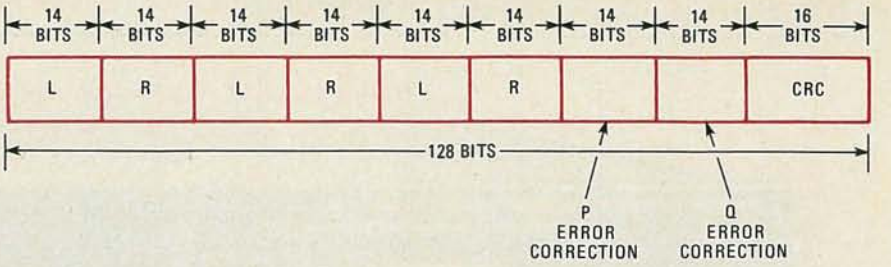


FIG. 2—EACH HORIZONTAL LINE contains six audio words, two error-correction words (P and Q) and a sixteen-bit CRC word for error detection.

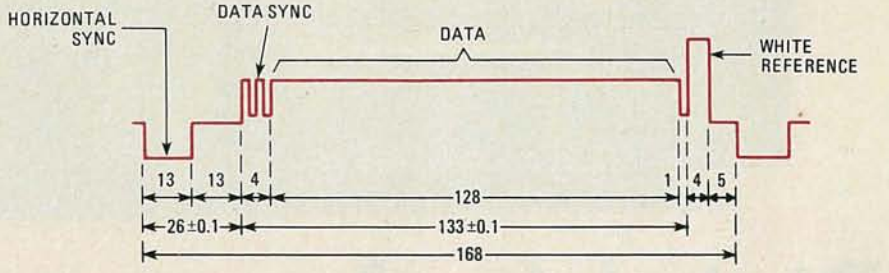


FIG. 3—ALTHOUGH ONE LINE can hold 168 bits, only 133 are used. The remaining space is occupied by standard video sync- and reference-signals.

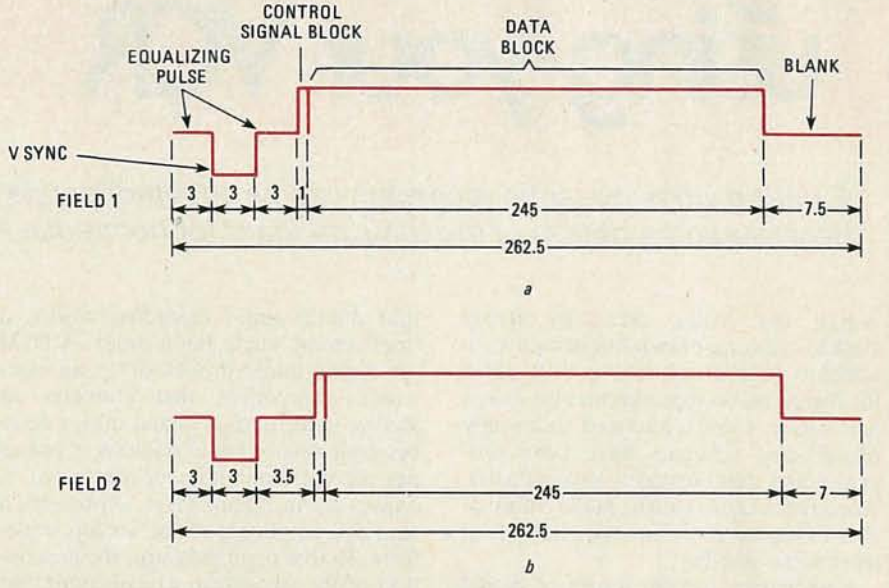


FIG. 4—OF THE 262.5 lines in each video field, 245 are used for the storage of audio data. An additional line is used for a control-signal block. Both fields of a video frame are shown.

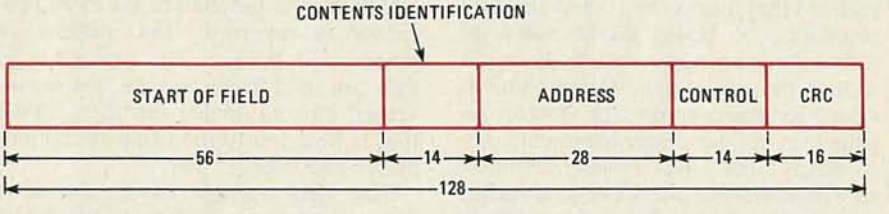


FIG. 5—CONTROL-SIGNAL BLOCK uses one line and contains information required for processing the audio data.

sampled audio signals (interleaved as L, R, L, R, etc.), followed by two words (known as P and Q codes) for error correction, and a 16-bit CRC (*C*yclic *R*edundancy *C*heck) word for error detection. In order to take care of possible long dropouts in the tape, succeeding words of the sampling code are actually separated by 16 horizontal lines. That is, if the first 14-bit word of the first line of a field is sample number 1 of the left-channel audio amplitude, then sample number 1 of right channel audio amplitude will appear displaced

by one word space, but *sixteen lines later* in the encoded sequence.

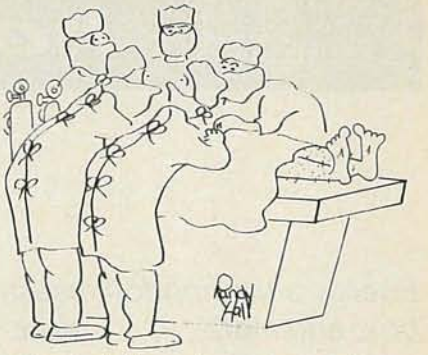
As shown in Fig. 3, each complete horizontal line contains space for 168 bits, but only 128 bits of data per line are used. The remaining space is used for the horizontal-sync pulse, data-sync pulses, and various other signals that are required by the VCR for a standard TV signal format.

The signal format for a single video field (there are two fields per frame and 30 frames per second) contains 262.5 horizontal lines of data, as shown in Fig. 4. (The first field of a frame is shown in Fig. 4-a; the second in Fig. 4-b.) Of those available lines per field, 245 lines are used for digital-audio data storage, while one horizontal line is used for a control-signal block. The control-signal block line is made up of 56 bits for indicating the start of the data block in each field; 14 bits for content identification; 28 bits for "address;" 14 bits for control, which includes a copy-prohibiting code; identification codes for the P and Q error-correction words; and a pre-emphasis-identification code, and 16 bits for the cyclic redundancy error-detection code. The contents of this control line are illustrated in Fig. 5.

We have referred several times to error-correction in discussing the new EIAJ PCM standards. Error correction is a vital part of any digital-information storage system. Dropouts caused by a tape's coating-irregularities or by poor contact with the tape head's surface may be insignificant and inaudible when they occur in a conventional analog tape-playback system; but losing even a couple of microseconds of data in a digital system can significantly alter the numeric code that is to be reconverted to an audio signal. For that reason, the error-correction system included in the EIAJ standard format is highly sophisticated. The error-correction system can be instructed to "fill in" the amplitude of the previous word in the number code, or the average of the preceding and succeeding words, so that, in case of any dropouts during playback, a smooth continuity of sound is always maintained.

No one can predict how soon prices for PCM processors will plunge low enough to make it practical for many of you to abandon your open-reel and cassette decks in favor of this new recording technique. In professional applications, many larger studios are already utilizing digital recorders (most of which use a 16-bit system for even lower distortion and greater dynamic range) for making and editing master tapes from which records are ultimately produced and pressed.

At the consumer level, the only manufacturer to offer a PCM processor for home use as of this writing (aside from small quantities of prototype production previously offered by Sony and others) is Sanyo, a relative newcomer to the ultra-high-fidelity field. Their unit, the *PCM Plus 10*, carries a suggested retail price of $3995. To that, of course, must be added the cost of a video-cassette recorder. Those are not exactly the kind of prices that will bring hordes of anxious customers to dealers who stock the PCM processor. But technology has a way of moving quickly, and future advances may well make the PCM processor as affordable and popular as the cassette recorder is today. **R-E**



"He should have known better than to tangle with a solid-state computer."

hobby corner

Energy consumption measurements, some clocks, an idiot box, and more.

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

MOST OF US ARE VERY CONSCIOUS OF energy consumption these days, and we have various reasons for that concern. Some of us are concerned about the limited amounts of energy available to our civilization. Others worry about how to pay their energy bills and thus are interested in keeping consumption as low as possible.

Whatever the specific reason, we *do* want to keep our energy use down to a minimum. To do that effectively, we need some way of knowing just how much energy we are using. We can still read the electric meter and the dials on the gasoline pump, but more information is needed. Staying with electrical energy for the time being, we need to know just how much a given appliance is using at a particular time, as well as its total usage.

Two readers have been working on different aspects of that problem. Frank Posthuma of Snohomish, WA has hit several snags in his attempt to design a digital circuit to measure energy usage from the AC line. Dale Glaser of Albany, CA is not having much success in measuring power used from a 12-volt battery backup system.

If you have figured out a way to make those or similar measurements, how about passing it along? Not only would Frank and Dale be grateful but the rest of us could put the method(s) to good use, too.

Dual clock

You'll recall Larry Neel's request for help in designing/building a dual time-zone clock. He wants a clock to keep local time and, with the push of a button, to display the time in another zone.

Perhaps the simplest solution came from David Lippincott of San Diego, CA. He calls our attention to the fact that Radio Shack has a complete LCD clock module (catalog No. 277-1007) with the two-zone capability.

Michael Kesti of Grass Valley, CA and Phelps Ter Heun of Ridgecrest, CA both wrote about a clock kit that meets the requirements. Coincidentally, Michael says that his clock IC has failed and the company is out of business. He cannot find a replacement for the house-numbered device. Phelps, writing about the same kit, mentions that the clock IC is really a Mostek MK50362N.

Thanks to those mentioned above and to the others who rallied to Larry's assistance. That information should solve his problem. In the meantime, I am astonished that no one has come up with a little circuit to put between a clock IC and the readouts to add (or subtract) from the "hour" digits.

One clock leads to another

Speaking of clocks, H. C. Gernhart of Princeton, WV is trying to avoid the high cost of a sidereal clock. (It seems that such a clock is of great advantage to those interested in astronomy.)

Well, I have forgotten more astronomy than I ever knew. However, I do seem to recall that sidereal time runs along at a constant pace—it's just a little slower than our "real" time. A sidereal day is 23 hours, 56 minutes and 4.09 seconds long, compared to our "normal" 24-hour one.

If he wishes, HC can look back at the Hobby Corner in the July 1979 issue of **Radio-Electronics** to find a way to make normal clock IC's run faster (or slower) than normal. It is only a matter of feeding a different frequency into the 50/60-Hz input pin. Do any of you have other ideas about a sidereal clock?

Idiot box entry

Don't forget that the idiot box "contest" is still running. The circuit shown in Fig. 1 is a slight modification of one sent in by Claude Elder of Aliquippa, PA. It is a little audio oscillator that is simple to build, yet has three controls for the panel to add interesting confusion to the operation.

Momentary switch S1 turns the sound on and off, and S2 controls the decay of the sound. The potentiometer controls the frequency (tone) of the sound. The parts values are not critical.

Most of the do-nothing circuit entries have involved sound in one way or another. How about some more with flashing lights and/or moving meters?

Interesting books

McGraw-Hill has added two very useful books to its Electro Skills series. One is for reference and the other is on CB repair.

A Reference Guide to Practical Electronics by Robert G. Krieger, Sr. contains a thorough treatment of 100 of the most commonly used electronics equations. The book covers subjects ranging from Ohm's law to some quite sophisticated topics. Each section follows this format: statement of the equation, definition of equation terms, thorough explanation, and examples of use.

This guide has information that should be near your workbench. It can help you through some of the tough ones.

How to Repair CB Radios by Lawrence E. Shultz does a good job of telling you how to do just what the title promises. It covers diagnosing, troubleshooting, and servicing 23- and 40-channel CB's. Power supplies and antennas are covered as well. Though this book is about CB equipment, the techniques explained and used are applicable to all kinds of receivers and transmitters.

These books should be available through your local bookstore but if you have a problem finding them, write Gregg/McGraw Hill, 1221 Avenue of the Americas, New York, NY 10020.

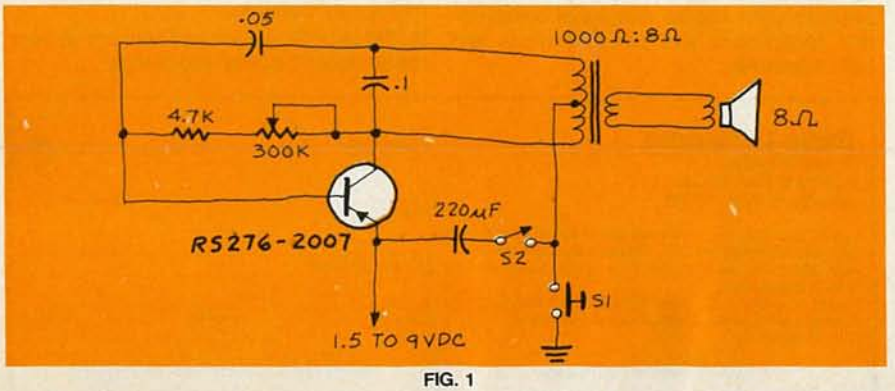


FIG. 1

Printed circuit know-how

Quite understandably, there is a lot of interest in making and using printed circuit boards. Of course, many articles have appeared in **Radio-Electronics** about PC work. We do make every effort to keep you informed about the latest developments. What so many of you seem to need, however, is a source of information about *all* the methods of fabricating boards.

Well, the Heath Company (Benton Harbor, MI 49022) has come to the rescue with their *EI-3134 Printed Circuit Course*. In addition to the 390-page self-study manual, this program includes all materials for making boards using a wide variety of methods plus two useful kits that use the PC boards you make: the *model GD-600* photoelectric light switch and the *model GD-1287* touch control switch. When you finish the course, you not only have the knowledge you need, but you have two items to use around the house or shop.

The course is well planned, and is written in clear, easy-to-understand language. It covers the selection of material and method, design, art work, PC-board fabrication, and board assembly.

If you want to "put it all together" as far as PC boards go, give consideration to this course. I am sure Heath will be glad to send you a catalog containing information about it, and the many other courses and kits they offer.

New catalog

If you have not seen the Fair Radio Sales Company (P.O. Box 1105, Lima, OH 45802) catalog, do yourself a favor and get one. Fair handles government and commercial electronic surplus and their catalog includes receivers, transmitters, subassemblies, motors, meters, test instruments, and parts.

A little shocker

The circuit shown in Fig. 2 is quite interesting. Closing momentary switch S1 produces a "shocking" high voltage on the transformer. The electronic principles here are the same as found in cattle prods and similar devices. Of course, this one is a bit on the weak side.

The 555 is wired as an oscillator that turns the transistor switch on and off. The transistor is any power NPN—a power-tab audio type works well. One of the smaller variety such as the Radio Shack No. 2008 can be used if you limit the on-time to brief intervals to prevent burning it out.

As the transistor switches, current is allowed to pulse thorugh the transformer. The rapid building and collapsing of the magnetic field places a much higher voltage on the transformer output.

Finding a proper transformer may cause a bit of a problem. What you need is an audio-output type made for use with tubes—the higher the turns ratio, the better. If you can scrounge one out of an old tube-type radio or TV, probably it will do quite well.

Notice that the transformer is wired backwards, as it were. The circuit is connected to the secondary (the side that was connected to the speaker). Of course, that makes the high impedance (former) primary side the output.

If you need a small source of low-current high-voltage pulses, this circuit may be just the thing. Watch the on/off button—the current drain of this thing will eat up a battery in short order. **R-E**

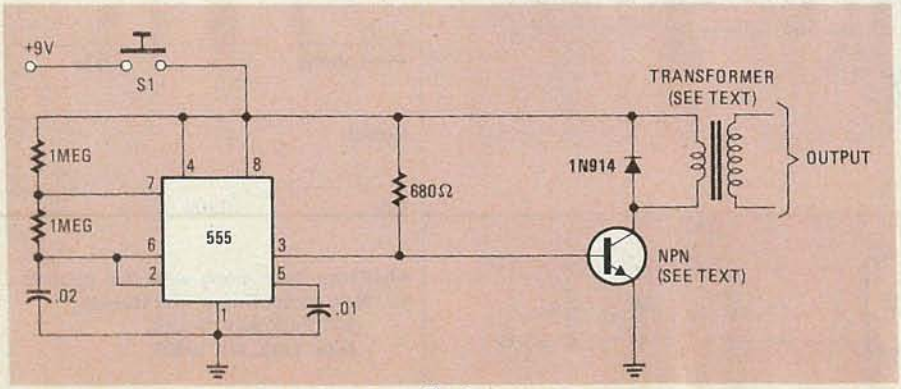


Fig. 2

new ideas

POOL-PUMP TIMER

AS SUMMER TEMPERATURES GO UP, SO does the use of electricity. For those who own swimming pools, a large part of that increased electrical usage is caused by the swimming-pool pump. Although most pumps are set up to run continuously, that type of operation is unnecessary in many cases.

The circuit (Fig. 1) described here is a pool-pump timer, or controller, that lets you run your pump for 15, 30, or 45 minutes out of an hour, rather than continuously. If you wish, the circuit can be disabled and the pump run continuously simply by turning the circuit's power switch to OFF.

The 555 timer IC is connected in the astable mode. Its output is adjusted by a potentiometer to give you a 2.27-Hz clock pulse. That clock pulse is applied to the input of the 4020, a 14-bit binary counter.

The differentiating circuit (C3, R3) resets the counter when the device is first turned on. After the 4096th clock pulse, pin 3 of the counter goes high and stays high until the 8192nd clock pulse. When that happens, pin 3 goes low again.

Using a clock frequency of 2.27 Hz, it will take about 30 minutes for pin 3 to go high and about 30 more minutes for it to go low again. The output of the counter is applied to one input of the 4011 NAND gate. To get the timing for the 30-minute "on" state, a logic "high" (12 volts) is applied to the other input of the NAND gate, and the gate's

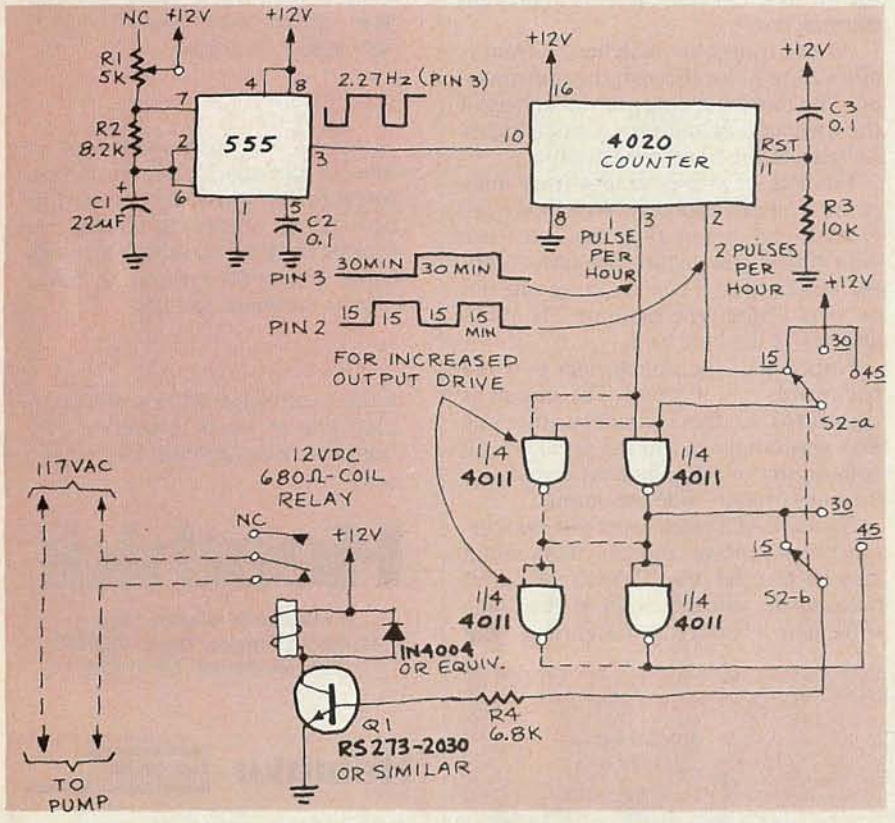


FIG. 1

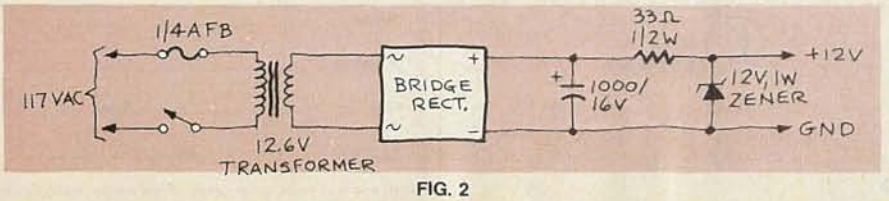


FIG. 2

NEW IDEAS

This column is devoted to new ideas, circuits, device applications, construction techniques, helpful hints, etc.

All published entries, upon publication, will earn $25. In addition, Panavise will donate their model 324 Electronic Work Center, having a value of $49.95. It combines their circuit-board holder, tray base mount, and solder station (see photo below). Selections will be made at the sole discretion of the editorial staff of **Radio-Electronics.**

I agree to the above terms, and grant **Radio-Electronics** Magazine the right to publish my idea and to subsequently republish my idea in collections or compilations of reprints of similar articles. I declare that the attached idea is my own original material and that its publication does not violate any other copyright. I also declare that this material had not been previously published.

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output is connected through R4 to the base of Q1.

To get the 15-minute "on" state, the logic "high" is removed from the input of the NAND gate and the output from pin 2 of the 4020 is connected in its place. When that is done, the output of the gate is high for 45 minutes and low for 15 minutes. To get the 45-minute "on" state, the output from the 15-minute "on" state is simply inverted using a second NAND gate. Another pair of NAND gates may be used in parallel with the first if you find that more drive is needed.

The transistor switch, Q1, saturates when the input to its base is high. When that happens, current flows and energizes the relay. The pool pump is connected to the relay's normally closed contacts and is turned off when the relay is energized.

Construction is straightforward, and any method can be used. Wire wrap was used to build the prototype. The only important point to remember is that the relay contacts must be capable of handling the current drawn by the pump. Any 12-volt power supply may be used, but a regulated supply such as the one shown in Fig. 2 is advisable.

That's all there is to it. I'm sure that you'll find, as I did, that this circuit will make running your pool a lot less expensive this summer. —*Tim Landreth*

service questions

VERTICAL PROBLEM

Fred Steurer, of Hamilton, OH, sends along a hint on the vertical oscillator time-constant problem we covered in the January 1981 issue of **Radio-Electronics** (Service Questions). He says that this problem can also be caused by the vertical-hold control if it has leakage to the case. Thank you!

BURNING RESISTOR

I've got a peculiar problem! This Magnavox T940 burns out T302, a 1000-ohm, 3-watt resistor (actually a thermistor) in series with the vertical-output transformer primary. There is only a 28-volt drop across it, showing less than 1 watt dissipation! A 50-µF capacitor on the bottom end of the primary (C107C) shows no shorts or leakage. With a new resistor, the vertical sweep is normal until the resistor blows.—K.Y., Marysville, MI

You've proved that the overload isn't due to DC, so, there's only one possibility left—excess AC current! There is a very high pulse present at the top of the primary, and the big capacitor is meant to get rid of it at the bottom end. I don't think it is working.

Check the bottom of the primary with an oscilloscope. If you see a high pulse-voltage, replace that capacitor. An easy way to check is to disconnect the capacitor and tack in a new one for testing. The cause of problem is a high pulse-voltage flowing through resistor and grounding through good capacitors in the B+!

TRANSFORMER SUBSTITUTION

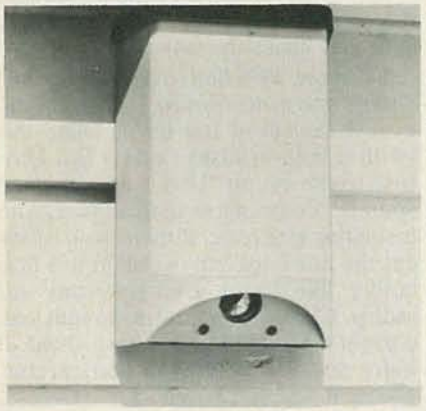
In the December 1980 issue of **Radio-Electronics,** I had a question about replacing power transformers in audio amplifiers. I suggested a 12-volt filament transformer. A reader in Canada disagrees with that! He says that the original transformers have a built-in fuse! (*Mostly imports, I think*—Editor) If a stock transformer is used, the next fault may cause the amp to burn up.

I'll agree with him, in principle. As I should have mentioned before, whenever I replace a transformer like this (with a built-in fuse) I add a fast-blow fuse to the circuit! This is easier than it sounds. You can use a pigtail fuse, with insulating sleeve or, if there is no room, cut the line cord and use an in-line fuse holder like those used on many car radios. Check the actual maximum load current and don't use a fuse rated at more than about 120% of that current. For a 0.7-amp current, for example, use a 1-amp fuse. **R-E**

new products

HOME SECURITY-SYSTEM KIT, *model GD-3510* Security Light Control, uses a passive infra-red sensor to detect changes in temperature, when accompanied by motion, in a 25-by-25-foot range. When a warm-bodied object moves through the field, lights and/or other devices (up to the *model GD-3510's* 500-Watt capactiy) are turned on.

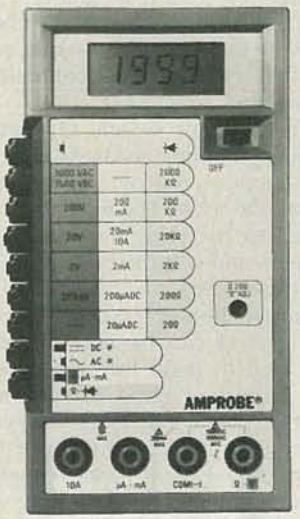
Sensitivity-level may be preset manually to prevent false triggering. Built-in safeguards prevent the system from triggering false alarms during daylight, or because of temperature changes without movement. The *model GD-3510*, specially packaged in easy-to-assemble kit form with a step-by-step assembly manual, is priced at $139.95—**Heath Company,** Benton Harbor, MI 49022.



CIRCLE 50 ON FREE INFORMATION CARD

DIGITAL MULTIMETER, *model AM-4*, is a digital multimeter with ranges and capabilities for industrial use. The ranges are 0-1.999/19.99/199.9 volts AC/DC plus 0-1000 VAC, and 0-1500 VDC (15K VAC/DC can be added with an accessory high-voltage probe); 0-19.99/199.9 μA AC/DC, 0-1.999/19.99/199.9 mA AC/DC, 0-10 amps AC/DC (0-300/1000/6000 amps AC can be added with accessory clamp-on current transducers); 0-19.99/199.9 ohms, 0-1.999/19.99/199.9K ohms plus a special diode test range; 0-199.9 mV AC/DC. An AC leakage range (0-1.999 mA AC) for checking 115/230 VAC appliances can be added with an accessory leakage detector.

The accuracy specifications are: DC, ±0.8% of reading ±LSD; AC, ±1.5% of reading ±LSD based on 45-500 Hz sinusoidal waveform. (Accuracy on 0-20/200 μA ranges may be affected by outside interference.) Resistance is ±1% of reading ±2 LSD. Clamp-on, AC current transducers add ±½% of reading; 15K VAC/DC high-voltage probe adds up to ±2% of reading. The leakage detector meets and exceeds ANSI requirements.



CIRCLE 141 ON FREE INFORMATION CARD

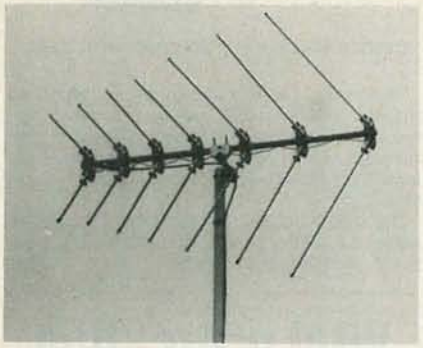
The *model AM-4* features auto-zeroing on all ranges except the very sensitive 0-20-ohms range. On the 0–20 ohms range, it may be necessary to use the ohm-zero adjust to zero the instru-

ment. Size is 6 13/16 × 3 13/16 × 1 11/16 inches; weight 11 ounces. MTL all-weather test leads are supplied.

The *model AM-4* is priced at $129.85.—**Amprobe Instrument,** 630 Merrick Road, Lynbrook, NY 11563.

BROADBAND VHF/UHF BEAM ANTENNA, the *Scanner Beam,* is intended primarily for the hobby scanner and is designed to work over the continuous frequency range from 108 through 512 MHz. The antenna consists of a seven-element, log-periodic array with a gain approaching 8-dB above a dipole on the high band and UHF. The 15-db front-to-back ratio makes the *Scanner Beam* suitable for long-distance, weak-signal directional reception; average VSWR is 1.92:1. On low band (30-50 MHz), the antenna resembles an omni-directional vertical antenna.

The *Scanner Beam* is constructed of heavy-duty aluminum tubing, and features unbreakable Cycolac insulators, a 4-foot baked-enamel painted boom, and includes a 4:1 matching balun transformer for either 50- or 75-ohm coaxial feedline. A universal offset mount permits it to be attached to a metal mast with a minimum of interaction, and further allows the antenna to be tilted in a vertical plane for satellite reception. It is also useful for transmitting in the 144, 220-and 420-MHz bands.



CIRCLE 142 ON FREE INFORMATION CARD

The *Scanner Beam* is priced at $39.95, plus $4.00 for shipping. A matching coaxial cable assembly, 65 feet long, with factory-installed "F" connector, Motorola connector, and weather boot costs $14.95 plus $4.00 shipping.—**Grove Enterprises, Inc.,** Route 1, Box 156S, Brasstown, NC 28902.

CASSETTE INTERFACE, the *Fastload,* is a device that inputs prerecorded programs into *TRS-80* Model I, Level II computers at 16 times the normal speed. Any cassette of up to C-20 in length can be loaded at 8000 baud using a modified *CTR-41* recorder plus the *Fastload.* For short programs the *Fastload* is faster than disk and

CIRCLE 143 ON FREE INFORMATION CARD

longer programs load in seconds rather than minutes. The unit is a small box that is placed under the cassette recorder and plugs into either the back of the *TRS-80* 16K keyboard or the expansion interface. The *Fastload* does not require transferring all programs to another medium first. A modified *CTR-41* cassette tape recorder must be used with the *Fastload.* The modification allows both the PLAY and FAST FORWARD controls to be latched down at the same time so that the head is in contact with the tape at the fast-forward speed. To use the *Fastload,* the user initializes with a system command after turning on the *TRS-80;* then the LOAD command can be used. Price for the *Fastload* Cassette Interface is $188.00; the modified *CTR-41* recorder is $95.00.—**Personal Micro Computers, Inc.,** 475 Ellis St., Mountain View, CA 94043.

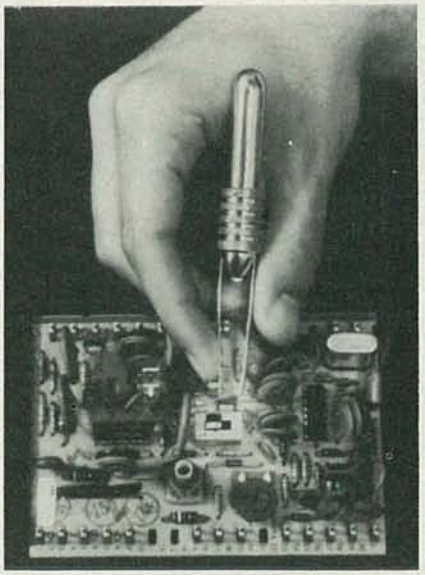
BASS ACTIVATOR/SUBSONIC FILTER, *model DF120 Bass Bomb,* provides variable bass-frequency selection of 40 Hz to 160 Hz with a 0 to 12-dB bass-boost level control while using a filter to eliminate subsonic noise. Attached to the preamp and amplifier, the subsonic filter automatically protects speakers and amplifiers from unwanted voltage spikes and also minimizes subsonic noise from turntable, tone arm, acoustic feedback, and warped records. Other features are elimination of distortion under 20 Hz, a slide

CIRCLE 144 ON FREE INFORMATION CARD

control for selecting the most desired frequency, and the option to keep subsonic filter in-circuit even when bass boost circuitry is turned off. Suggested retail price is $99.95.—**Numark Electronics Corp.,** 503 Raritan Ctr., Edison, NJ 08817.

PRECISION TWEEZERS, are battery-powered lighted tweezers, with stainless steel blades. They are powered by a single AAA battery, and the lamp directs the light to the working area.

A low-cost plastic-case model is available that is ideal for field tool cases, just what is needed for working in poorly-lighted field situations. Two stainless-steel case models are also available, one with a straight tip, and one with an angle tip. The steel cases will last many years on the industrial assembly bench.



CIRCLE 145 ON FREE INFORMATION CARD

The plastic-cased tweezers are priced at $5.68; the steel tweezers are $16.98.—**Desco Industries, Inc.,** 351 F Oak Place, Brea, CA 92521.

CB RADIOS, President *models AR-711* and *AR 144:* The *model AR 711* (shown), designed and built to the specifications of truckers and other

continued on page 76

professional users, features a noise-cancelling microphone with an extra-long coil that extends to 10 feet. There is also a 4-inch external speaker, with mounting bracket and 5-foot cable; instant-select channel-9 and channel 19 switches; auto-

CIRCLE 146 ON FREE INFORMATION CARD

motive protective knobs, and a HI-CUT tone switch. Other features include MIKE GAIN, RF GAIN, ANL/NB, S/RF meter, digital channel indicator, TX and RX indicators, positive/negative ground, automatic modulation control, PA and external speaker jacks. There is also a plug-in DC power cord.

The *model AR 144* is a 40-channel AM/SSB mobile CB radio featuring NB/ANL, Channel-9 priority, brite-dim, mode and PA-CB switches, plus MIKE GAIN, RF GAIN, and CLARIFIER controls. Other features include S/RF meter, digital channel indicator, TX/RX mode and channel-9 indicators, automatic modulation control, detachable dynamic microphone, positive/negative ground, PA and external speaker jacks, and plug-in DC power cord.

The *model AR 711* has a suggested retail price of $139.95; the suggested price for the *Model AR 144* is $219.95. Both models carry a two-year full warranty.—**American Radio Corporation,** 6330 Castleplace Drive, Indianapolis, IN 46250.

FLOOR-STANDING SPEAKER SYSTEM, *model L150A,* is a successor to the *model L150,* and has a high-frequency dome radiator, equipped with a one-inch copper voice coil and two-pound magnetic assembly. Formed of lightweight phenolic material coated with aluminum, the dome reproduces the highest frequencies with superior depth and clarity, offering greater power-handling capacity as well. It also features a new high-resolution dividing network that provides the system with improved transient response throughout its range. The 12-inch low-frequency driver, in combination with a passive radiator, delivers exceptionally deep, distortion-free bass response. There is a five-inch midrange that provides accurate, natural sound at all levels.

CIRCLE 147 ON FREE INFORMATION CARD

The *model L150A's* maximum recommended amplifier power is 300 watts-per-channel. The nominal impedance is 8 ohms. Crossover frequencies are 1.1 kHz and 9.7 kHz, the system's sensitivity is 89 dB sound-pressure level (1 watt/1 meter).

The *model L150A* is priced at $695.00 each.—**James B. Lansing Sound, Inc.,** 8500 Balboa Boulevard, Northridge, CA 91329. **R-E**

continued from page 60

If all else fails, you'll have to write a simple version of PARAM just for this package.

Once you have found the command interpreter, you must determine if the entries in the command table are of fixed or of variable length. Variable-length entries are usually marked by setting the most significant bit of the command's last character high. To make a short command work in a table of fixed-length commands, pad it with blanks. The end of the table may be detected either by a counter's reaching zero, in which case an adjustment to the program will be necessary, or by the inclusion of an end-of-table marker.

To construct the routines in BASIC, you must have commands available that allow input and output to specific I/O ports. An input command that "hangs up" until data is ready will not work.

In BASIC, the indirect calls used in the assembly-language program are not practical. Replace them with a multiway branch structure (ON–GOTO, IF–THEN–GOTO, etc). Each subroutine will then have to end with "GOTO *start*".

Once the software is written and seems to run without "crashing," you are ready to try it with the hardware.

Connect the modem to the computer's serial port and apply power. Typical RS-232 connections were shown in Part 2, in the July 1981 issue of **Radio-Electronics.**

Your modem will emit a tone whenever it is on. Use your new program to select the options compatible with the installation you intend to communicate with. Without calling anyone, enter the emulator program by typing the TE (or your equivalent) command. The modem should "bleep" immediately upon entry to the emulator and with each key closure thereafter. You should also be able to fill the screen or teletype with garbage by whistling near the modem's microphone.

If everything appears to work, exit the emulator program and if you installed a separate power switch, turn off the modem. (The switch makes it easier to establish a connection with certain time-sharing operations.) Double-check all options, including the channel-select switch on the modem.

To call a big time-sharing service you will want your modem to transmit on the *lower* ORIGINATE band. Dial the number. When you hear the ANSWER tone, place the telephone handset into the coupler with the phone's mouthpiece in the modem's "speaker" muff. (Try to do this gently as some noises can disconnect you.) As soon as the handset is seated, turn on the modem and invoke the emulator by typing "TE."

BUILD A $60 MODEM

continued from page 77

The system called should respond with the "log-on" prompt. If it doesn't, recheck the selection of options—especially the recognition character and channel—and try again. (You must hang up and then redial.) If you still have no success, repeat the hardware and software tests that were recommended earlier. Try to isolate the general source of your trouble. If you have a patient friend who has a modem, he can be a great help. Get him to send you data while you try various combinations of options. If the problem is in the modulator-half of your modem, have him monitor your transmissions, informing you each time you transmit something accurately.

The important question of whether the problem is in the modem or in the computer can be best answered by substituting your modem for the modem in a working system—perhaps even one at a computer store. Finally, don't overlook the telephone itself. The most frustrating problem we have encountered was produced by a desk phone with a bad duplex network.

Once your system is running, you can look forward to making new friends via the CBB's (*C*omputer *B*ulletin *B*oards) and programs like *MicroNET's* CB simulator. You will also have access to a very broad source of programs and information utilities. And the future promises even more. A word of caution, though, to the overenthusiastic: long-distance is sometimes the next best thing to bankruptcy! **R-E**

REFERENCES

Roger L. Hicks, "RS-232", *80 Microcomputing*, March 1980, p. 136 (a good source of serial-port information for TRS-80 users).

Austin Lesea, Rodnay Zaks, *Microprocessor Interfacing Techniques*, Sybex, 1977.

Garth Nash, "Low-Speed Modem Fundamentals," Motorola application note AN-731.

Don Lancaster, *TV Typewriter Cookbook*, Howard W. Sams, 1978.

8-BALL ANTENNA

continued from page 48

threaded rods without heads and require a nut and washer on each side of the wood strip. Tighten the bolts and attach the vertical wood strip/bolt assemblies to the frame as shown in Figs. 5 and 6, using a 1/4-inch nut on each side of the metal rib as shown. Set the spacing between the vertical wood strips and the frame according to the dimensions in Fig. 5, but tighten the bolts just finger-tight.

For ease in setting the spacing between the rib and the redwood vertical strip, cut 13/16-inch, 3 7/32-inch, and 7 1/4-inch spacer blocks. Use them to set the spacings at points 24, 48, and 72 inches up and down from center. (See Fig. 5.) Figure 9 shows the 7 1/4-inch spacer in place while one of the 12-inch bolts is being adjusted.

It is very important to position the vertical strips so that the horizontal strips lie flat across them. That is why the adjustment bolts were left just finger-tight—to allow for the slight left or right movement necessary for alignment. Once the horizontal strips have been installed, the adjustment bolts will be tightened.

Attach the 3/4×2-inch horizontal wood strips to the vertical strips as shown in Fig. 4. At each lattice joint use glue and a 1 1/4-inch brass screw. Pre-drill the screw holes—preferably with a pilot drill—otherwise you're likely to break the screw or split the wood.

We'll show you how to handle the lattice corners when we continue with the 8-Ball next month. **R-E**

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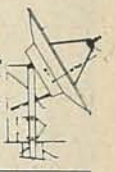

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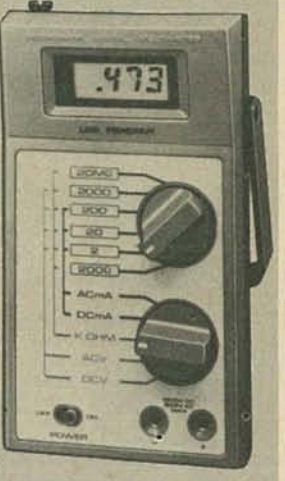

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93417/82S126	3.45	1K, 16 PIN
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7401N	.22	74247N	1.24	74LS55N	.24
7402N	.24	74251N	.76	74LS73N	.32
7403N	.24	74259N	1.89	74LS74N	.32
7404N	.24	74273N	1.99	74LS75N	.35
7405N	.24	74276N	.98	74LS76N	.38
7406N	.36	74278N	2.38	74LS78N	.29
7407N	.36	74279N	.59	74LS83N	.69
7408N	.24	74283N	.98	74LS85N	.84
7409N	.24	74293N	.72	74LS86N	.38
7410N	.24	74298N	.84	74LS90N	.39
7412N	.36	74351N	2.20	74LS91N	.89
7413N	.39	74365AN	.58	74LS92N	.48
7414N	.39	74366N	.69	74LS93N	.39
7416N	.36	74367AN	.58	74LS95N	.48
7417N	.36	74368AN	.58	74LS96N	.58
7420N	.29	74390N	.96	74LS107N	.36
7422N	.36	74393N	1.29	74LS109N	.36
7423N	.36			74LS112N	.36
7425N	.32	74SOON	.36	74LS122N	.48
7426N	.39	74S02N	.38	74LS123N	.59
7427N	.32	74S03N	.38	74LS125N	.44
7428N	.42	74S04N	.44	74LS126N	.44
7430N	.22	74S05N	.48	74LS132N	.52
7432N	.39	74S08N	.48	74LS133N	.98
7433N	.39	74S09N	.59	74LS136N	.42
7437N	.36	74S10N	.48	74LS138N	.48
7438N	.36	74S11N	.48	74LS139N	.48
7440N	.22	74S15N	.48	74LS145N	1.09
7442N	.44	74S20N	.48	74LS147N	1.98
7445N	.84	74S30N	.36	74LS148N	1.36
7446N	.84	74S32N	.64	74LS151N	.42
7447AN	.65	74S37N	.89	74LS153N	.35
7450N	.22	74S38N	.89	74LS155N	.67
7451N	.29	74S40N	.39	74LS156N	.72
7453N	.29	74S51N	.48	74LS157N	.48
7454N	.29	74S74N	.58	74LS158N	.48
7472N	.36	74S85N	1.98	74LS160N	.69
7473N	.36	74S86N	.72	74LS161N	.58
7474N	.36	74S112N	.72	74LS162N	.72
7475N	.39	74S114N	1.29	74LS163N	.58
7476N	.38	74S124N	2.56	74LS164N	.58
7483AN	.48	74S132N	1.24	74LS165N	.89
7484AN	1.36	74S133N	.48	74LS166N	1.64
7485N	.66	74S134N	.54	74LS170N	1.59
7486N	.39	74S135N	1.29	74LS173N	.59
7490AN	.32	74S138N	.96	74LS174N	.39
7491AN	.42	74S139N	.96	74LS175N	.39
7492AN	.38	74S140N	.74	74LS181N	1.98
7493AN	.38	74S151N	.99	74LS189N	4.45
7494AN	.68	74S153N	.96	74LS190N	.72
7495AN	.54	74S157N	.96	74LS191N	.72
7496N	.59	74S158N	.96	74LS192N	.64
7497N	1.89	74S161N	2.85	74LS193N	.64
74100N	1.38	74S162N	3.70	74LS194N	.64
74104N	.64	74S163N	3.54	74LS196N	.88
74107AN	.44	74S168N	4.45	74LS197N	.89
74109N	.44	74S169N	4.45	74LS221N	.89
74110N	.45	74S174N	.96	74LS240N	.89
74111N	.58	74S175N	.96	74LS241N	.89
74116N	1.20	74S181N	3.95	74LS242N	.89
74120N	1.25	74S182N	1.69	74LS243N	.89
74121N	.48	74S189N	4.45	74LS244N	.89
74122N	.52	74S194N	1.68	74LS245N	1.65
74123N	.48	74S195N	1.68	74LS247N	.76
74125N	.48	74S201N	5.85	74LS248N	1.09
74126AN	.48	74S225N	4.95	74LS249N	.96
74128N	.64	74S240N	2.95	74LS251N	.54
74132N	.45	74S241N	2.95	74LS253N	.54
74136N	.52	74S244N	2.95	74LS257N	.56
74141N	.84	74S251N	1.19	74LS258N	.56
74142N	2.98	74S253N	1.95	74LS259N	1.29
74143N	3.44	74S257N	1.09	74LS260N	.89
74144N	3.44	74S258N	1.09	74LS266N	.36
74145N	.67	74S260N	.98	74LS273N	1.19
74147N	1.24	74S274N	25.85	74LS275N	3.95
74148N	.89	74S275N	25.85	74LS279N	.48
74150N	1.25	74S280N	1.98	74LS280N	1.98
74151N	.42	74S283N	2.95	74LS283N	.78
74153N	.36	74S299N	5.85	74LS290N	.72
74154N	1.29	74S373N	2.98	74LS293N	.38
74155N	.48	74S374N	2.98	74LS298N	.88
74157N	.48	74S381N	5.95	74LS299N	2.50
74159N	1.52	74S412N	2.98	74LS320N	2.75
74160N	.48	74S471N	6.45	74LS321N	3.95
74161AN	.64	74S472N	8.45	74LS322N	4.95
74162N	.64	74S474N	9.65	74LS323N	4.95
74163AN	.64	74S476N	5.95	74LS324N	2.50
74164N	.64			74LS348N	2.65
74165N	.64	74LSOON	.17	74LS352N	1.35
74166N	.68	74LS01N	.17	74LS353N	1.65
74170N	1.98	74LS02N	.22	74LS362N	9.95
74172N	4.95	74LS03N	.22	74LS365N	.52
74173N	.79	74LS04N	.22	74LS366N	.52
74174N	.58	74LS05N	.22	74LS367N	.52
74175N	.58	74LS08N	.17	74LS368N	.52
74176N	.76	74LS09N	.24	74LS373N	1.25
74178N	1.09	74LS10N	.19	74LS374N	1.25
74179N	1.09	74LS11N	.24	74LS375N	.64
74180N	.75	74LS12N	.24	74LS377N	1.25
74182N	.52	74LS13N	.25	74LS378N	.99
74184N	2.36	74LS14N	.39	74LS379N	1.09
74185N	2.36	74LS20N	.18	74LS390N	.98
74190N	.68	74LS21N	.18	74LS393N	.98
74191N	.68	74LS26N	.39	74LS395N	1.19
74192N	.68	74LS27N	.29	74LS447N	.37
74193N	.64	74LS30N	.18	74LS490N	1.89
74194N	.64	74LS32N	.29	74LS630N	85.00
74195N	.48	74LS37N	.29	74LS669N	.84
74196N	.78	74LS38N	.29	74LS670N	1.64
74197N	.72	74LS42N	.44		
74198N	1.39	74LS47N	.68		
74199N	1.39	74LS48N	.99		
74221N	.68	74LS51N	.21		

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CD4001BE	.18	CD4040BE	.64	CD4108BE	1.69
CD4002BE	.18	CD4041BE	.89	CD4510BE	.58
CD4006BE	.59	CD4042BE	.54	CD4511BE	.56
CD4007BE	.24	CD4043BE	.70	CD4512BE	.72
CD4008BE	.67	CD4044BE	.48	CD4514BE	1.68
CD4009BE	.39	CD4046BE	.96	CD4515BE	1.54
CD4010BE	.39	CD4047BE	.69	CD4516BE	.75
CD4011BE	.18	CD4049BE	.38	CD4519BE	.52
CD4012BE	.18	CD4050BE	.32	CD4520BE	.56
CD4013BE	.29	CD4051BE	.79	CD4522BE	.78
CD4014BE	.56	CD4052BE	.79	CD4526BE	1.25
CD4015BE	.56	CD4053BE	.79	CD4527BE	1.59
CD4016BE	.32	CD4060BE	.89	CD4528BE	.72
CD4017BE	.54	CD4066BE	.48	CD4531BE	.84
CD4018BE	.52	CD4068BE	.24	CD4532BE	.84
CD4019BE	.48	CD4069BE	.18	CD4539BE	.59
CD4020BE	.68	CD4070BE	.24	CD4543BE	1.44
CD4021BE	.57	CD4071BE	.24	CD4553BE	2.89
CD4022BE	.79	CD4072BE	.19	CD4555BE	.58
CD4023BE	.19	CD4073BE	.24	CD4556BE	.58
CD4024BE	.44	CD4075BE	.24	CD4581BE	1.89
CD4025BE	.20	CD4076BE	.54	CD4582BE	.69
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CD4027BE	.42	CD4081BE	.18	CD4585BE	.79
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CD4033BE	1.67	CD4093BE	.58	40161PC	1.20
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LM311CH	1.03	LM556N-14	.52	LM1495CN-14	2.54
LM311N-8	.62	LM567CN-8	.84	LM1496CN-14	1.36
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IN4003	.06	IN4007	.08	IN5402	.17	IN5407	.25
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TIC236D	1.39	Triac	12 amp 400V	TO-220	
TIC246D	1.45	Triac	16 amp 400V	TO-220	
TIC263D	2.25	Triac	25 amp 400V	TO-220	
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TIP29C	.39	TIP42A	.57	TIP126	.77
TIP30A	.39	TIP42B	.59	TIP127	.84
TIP30B	.42	TIP42C	.64	TIP140	1.44
TIP30C	.42	TIP110	.54	TIP141	1.64
TIP31A	.38	TIP111	.57	TIP142	1.96
TIP31B	.42	TIP112	.64	TIP145	1.84
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2N697	.29	2N3440	.56	2N3704	.099	2N4403	.079	2N5771	.13	MPSA42	.16
2N706	.29	2N3771	1.29	2N3706	.099	2N4410	.15	2N5772	.14	MPSA43	.16
2N1613	.29	2N3772	1.29	2N3710	.099	2N5087	.12	PN2222A	.089	MPSA56	.12
2N1711	.29	2N3773	1.89	2N3904	.069	2N5088	.12	PN2369A	.089	MPSA70	.14
2N1893	.29	2N6133	.56	2N3906	.069	2N5172	.12	PN2907A	.089	MPSA92	.14
2N2222A	.19	2N6489	1.25	2N3907	.099	2N5220	.14	PN3565	.12	MPSA93	.12
2N2369A	.22	2N6545	4.75	2N4123	.075	2N5221	.14	PN3567	.12	MPSA14	.12
2N2484	.24	2N3439	.78	2N4124	.075	2N5223	.14	PN4249	.12	MPS2925	.12
2N2905A	.39	2N6059	2.45	2N4125	.075	2N5226	.14	PN5138	.099	MPS2926	.12
2N2907A	.19	2N6055	1.45	2N4126	.075	2N5227	.14	MPSA05	.12	MPS3391	.12
2N3053	.29	2N6079	3.85	2N4401	.079	2N5401	.15	MPSA06	.12	MPS3392	.12
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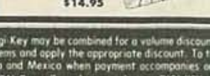

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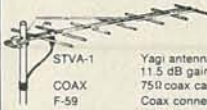

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8080A	CPU	4.95	2708	EPROM 1Kx8	4.50
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8088	CPU	44.95	4118	STATIC 1Kx8	15.00
Z-80	CPU	6.70	4164	200ns 64Kx1	Call
Z-80A	CPU	7.25	Z80B	CPU	21.00

NEC 1Kx4 STATIC RAM 250 N.S.

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2114L 250ns

8 for $25.00 32 for $96.00

Z80-P10	6.00	8755	49.95	4050	.69	4531	.99	74C925	6.95	74LS107	.45	74LS244	1.95
Z80A-P10	7.10	4000	.35	4051	1.10	4532	1.25	74LS00	.35	74LS109	.45	74LS245	4.95
Z80-CTC	6.00	4001	.35	4052	1.10	4539	.99	74LS01	.28	74LS112	.49	74LS247	1.10
Z80ACTC	7.10	4002	.35	4053	1.10	4543	1.99	74LS02	.28	74LS122	.55	74LS248	1.10
Z80-DMA	18.50	4006	1.39	4055	3.95	4553	3.50	74LS03	.28	74LS123	1.19	74LS249	1.69
Z80A-DMA	22.50	4007	.29	4056	2.95	4555	.75	74LS04	.39	74LS125	1.35	74LS251	1.79
Z80-S10/0	18.50	4008	1.39	4059	9.95	4556	.75	74LS05	.28	74LS126	.89	74LS253	.98
Z80A-S10/0	22.50	4009	.49	4060	1.39	4581	1.99	74LS08	.39	74LS132	.79	74LS257	.98
Z80-S10/1	18.50	4010	.49	4066	.75	4582	1.01	74LS09	.39	74LS136	.59	74LS258	.98
Z80A-S10/1	22.50	4011	.35	4068	.35	4584	.55	74LS10	.28	74LS138	.89	74LS259	2.95
Z80-S10/2	18.50	4012	.29	4069	.35	4585	.99	74LS11	.39	74LS139	.89	74LS260	.69
Z80A-S10/2	22.50	4013	.49	4070	.49	4702	9.95	74LS12	.39	74LS145	1.25	74LS261	2.49
3205	3.95	4014	1.39	4071	.35	74C00	.39	74LS13	.47	74LS148	1.49	74LS266	.59
3242	10.00	4015	1.15	4072	.35	74C02	.39	74LS14	1.25	74LS151	.79	74LS273	1.75
8155	11.25	4016	.59	4073	.35	74C04	.39	74LS15	.39	74LS153	.79	74LS275	4.40
8185	29.95	4017	1.19	4075	.35	74C08	.49	74LS20	.26	74LS155	1.19	74LS279	.59
8185-2	39.95	4018	.99	4076	1.29	74C10	.49	74LS21	.38	74LS156	.99	74LS283	1.10
8202	45.00	4019	.49	4078	.35	74C14	1.65	74LS22	.38	74LS157	.99	74LS290	1.29
8205	3.95	4020	1.19	4081	.35	74C20	.39	74LS26	.39	74LS158	.75	74LS293	1.95
8212	2.00	4021	1.19	4082	.35	74C30	.39	74LS27	.39	74LS160	.98	74LS295	1.10
8214	3.95	4022	1.15	4085	1.95	74C32	.99	74LS28	.39	74LS161	1.15	74LS298	1.29
8216	1.85	4023	.38	4086	.79	74C42	1.85	74LS30	.26	74LS162	.98	74LS324	1.75
8224	2.65	4024	.79	4093	.99	74C48	2.39	74LS32	.39	74LS163	.98	74LS347	1.95
8226	1.85	4025	.38	4099	2.25	74C73	.85	74LS37	.79	74LS164	1.19	74LS348	1.95
8228	5.00	4026	2.50	4104	1.99	74C74	.85	74LS38	.39	74LS165	.89	74LS352	1.65
8238	5.45	4027	.65	4501	.39	74C85	2.49	74LS42	.79	74LS166	2.49	74LS353	1.65
8243	4.65	4028	.85	4502	1.65	74C89	4.95	74LS47	.79	74LS170	1.99	74LS363	1.49
8251A	5.55	4029	1.29	4503	.69	74C90	1.85	74LS48	.79	74LS173	.89	74LS365	.99
8253	9.85	4030	.45	4505	8.95	74C93	1.85	74LS51	.26	74LS174	.99	74LS366	.99
8255A	5.40	4031	3.25	4506	.75	74C95	1.85	74LS54	.35	74LS175	.99	74LS367	.73
8255A-5	5.40	4032	2.15	4507	.95	74C107	1.19	74LS55	.35	74LS181	2.20	74LS368	.73
8257	9.25	4033	2.15	4508	3.95	74C151	2.49	74LS73	.45	74LS190	1.15	74LS373	2.75
8257-5	9.25	4034	3.25	4510	1.39	74C154	3.50	74LS74	.59	74LS191	1.15	74LS374	2.75
8259A	7.30	4035	.95	4511	1.39	74C157	2.10	74LS75	.68	74LS192	.98	74LS375	.69
8271	60.00	4037	1.95	4512	1.39	74C160	2.39	74LS76	.45	74LS193	.98	74LS377	1.95
8275	32.95	4040	1.29	4514	3.95	74C161	2.30	74LS78	.65	74LS194	1.15	74LS385	1.95
8279	10.80	4041	1.25	4515	3.95	74C163	2.39	74LS83	.99	74LS195	.95	74LS386	.65
8279-5	10.80	4042	.95	4516	1.69	74C164	2.39	74LS85	1.19	74LS196	.89	74LS390	1.95
8282	6.70	4043	.85	4519	.99	74C173	2.59	74LS86	.45	74LS197	.89	74LS393	1.95
8283	6.70	4044	.85	4520	1.39	74C174	2.75	74LS90	.75	74LS221	1.49	74LS395	1.70
8284	5.85	4046	1.75	4522	.99	74C175	2.75	74LS92	.75	74LS240	1.95	74LS399	2.95
8286	6.70	4047	1.25	4526	1.15	74C192	2.39	74LS93	.75	74LS241	1.90	74LS424	2.95
8287	6.70	4048	.99	4527	1.75	74C193	2.39	74LS95	.88	74LS242	1.95	74LS668	1.75
8288	25.40	4049	.69	4528	.99	74C195	2.39	74LS96	.98	74LS243	1.95	74LS670	2.29
8289	49.95												

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SN7404N	.25	SN7476N	.35	SN74162N	.89
SN7405N	.29	SN7479N	5.00	SN74163N	.89
SN7406N	.35	SN7480N	.50	SN74164N	.89
SN7407N	.35	SN7482N	.99	SN74165N	.89
SN7408N	.29	SN7483N	.69	SN74166N	1.25
SN7409N	.29	SN7485N	.89	SN74167N	2.79
SN7410N	.25	SN7486N	.35	SN74170N	1.95
SN7411N	.29	SN7489N	1.75	SN74172N	4.95
SN7412N	.35	SN7490N	.49	SN74173N	1.39
SN7413N	.40	SN7491N	.59	SN74174N	.99
SN7414N	.69	SN7492N	.45	SN74175N	.89
SN7416N	.29	SN7493N	.45	SN74176N	.79
SN7417N	.29	SN7494N	.69	SN74177N	.79
SN7420N	.25	SN7495N	.69	SN74179N	1.49
SN7421N	.29	SN7496N	.69	SN74180N	.79
SN7422N	.45	SN7497N	3.00	SN74181N	2.25
SN7423N	.29	SN74100N	1.49	SN74182N	.79
SN7425N	.29	SN74104	.89	SN74184N	2.49
SN7426N	.29	SN74105	.89	SN74185N	2.49
SN7427N	.25	SN74107N	.35	SN74190N	1.25
SN7428N	.49	SN74109N	.39	SN74191N	1.25
SN7430N	.25	SN74116N	1.95	SN74192N	.89
SN7432N	.29	SN74121N	.39	SN74193N	.89
SN7437N	.25	SN74122N	.55	SN74194N	.89
SN7438N	.40	SN74123N	.59	SN74195N	.69
SN7439N	.25	SN74125N	.49	SN74196N	.89
SN7440N	.20	SN74126N	.49	SN74197N	.89
SN7441N	.89	SN74132N	.75	SN74198N	1.49
SN7442N	.59	SN74136N	.75	SN74199N	1.49
SN7443N	1.10	SN74141N	.99	SN74221N	1.25
SN7444N	1.10	SN74142N	3.25	SN74251N	.99
SN7445N	.89	SN74143N	3.49	SN74276N	1.95
SN7446N	.79	SN74144N	3.49	SN74279N	.79
SN7447N	.69	SN74145N	.79	SN74283N	1.49
SN7448N	.79	SN74147N	1.95	SN74284N	3.95
SN7450N	.20	SN74148N	1.29	SN74285N	3.95
SN7451N	.20	SN74150N	1.25	SN74365N	.69
SN7453N	.20	SN74151N	.69	SN74366N	.69
SN7454N	.20	SN74152N	.69	SN74367N	.69
SN7459A	.25	SN74153N	.79	SN74368N	.69
SN7460N	.20	SN74154N	1.25	SN74390N	1.49
SN7470N	.29	SN74155N	.79	SN74393N	1.49

74LS

74LS00	.29			74LS192	1.15
74LS01	.29			74LS193	1.15
74LS02	.29	74LS92	.75	74LS194	1.15
74LS03	.29	74LS93	.75	74LS195	1.15
74LS04	.35	74LS95	.99	74LS197	1.19
74LS05	.35	74LS96	1.15	74LS221	1.19
74LS08	.29	74LS107	.45	74LS240	1.95
74LS09	.35	74LS109	.45	74LS241	1.95
74LS10	.29	74LS112	.45	74LS242	1.95
74LS11	.75	74LS113	.49	74LS243	1.95
74LS12	.35	74LS114	.49	74LS244	1.95
74LS13	.59	74LS122	.89	74LS245	2.95
74LS14	.99	74LS123	1.25	74LS247	1.19
74LS15	.35	74LS125	.89	74LS248	1.19
74LS20	.29	74LS126	.55	74LS249	1.19
74LS21	.35	74LS132	.99	74LS251	1.49
74LS22	.35	74LS133	.89	74LS253	.99
74LS26	.35	74LS136	.49	74LS257	.89
74LS27	.35	74LS138	.89	74LS258	.99
74LS28	.35	74LS139	.89	74LS260	.69
74LS30	.29	74LS151	.89	74LS266	.69
74LS32	.35	74LS153	.89	74LS273	1.95
74LS33	.59	74LS154	1.75	74LS279	.75
74LS37	.45	74LS155	1.19	74LS283	1.09
74LS38	.49	74LS156	1.19	74LS290	.99
74LS40	.35	74LS157	.89	74LS293	.99
74LS42	.89	74LS158	.99	74LS298	1.25
74LS47	.89	74LS160	1.15	74LS352	1.29
74LS48	1.15	74LS161	1.15	74LS353	1.29
74LS49	1.15	74LS162	1.15	74LS365	.75
74LS51	.29	74LS163	1.15	74LS366	.75
74LS54	.29	74LS164	1.25	74LS367	.75
74LS55	.29	74LS165	1.25	74LS368	.75
74LS73	.45	74LS168	1.19	74LS373	1.95
74LS74	.45	74LS169	1.19	74LS374	1.95
74LS75	.59	74LS170	2.49	74LS375	.89
74LS76	.45	74LS173	1.39	74LS386	.69
74LS78	.49	74LS174	.99	74LS393	2.49
74LS83	.89	74LS175	.99	74LS399	2.49
74LS85	1.25	74LS181	2.95	74LS670	2.49
74LS86	.45	74LS190	1.25	81LS95	1.95
74LS90	.59	74LS191	1.25	81LS97	1.95

74S

74S00	.50			74S243	3.25
74S02	.50			74S244	3.25
74S03	.50	74S124	2.49	74S251	1.45
74S04	.55	74S133	.55	74S253	1.45
74S05	.55	74S134	.69	74S257	1.35
74S08	.50	74S135	1.19	74S258	1.35
74S09	.50	74S136	1.75	74S260	.79
74S10	.50	74S138	1.35	74S280	2.95
74S11	.50	74S139	1.35	74S287	4.95
74S15	.50	74S140	1.15	74S288	4.95
74S20	.50	74S151	1.35	74S373	3.49
74S22	.50	74S153	1.35	74S374	3.49
74S30	.50	74S157	1.35	74S387	5.95
74S32	.55	74S158	1.35	74S471	19.95
74S38	.69	74S160	1.95	74S472	19.95
74S40	.55	74S174	1.59	74S473	19.95
74S51	.50	74S175	1.59	74S474	21.95
74S64	.50	74S188	4.95	74S475	21.95
74S65	.50	74S194	1.95	74S570	7.95
74S74	.79	74S195	1.95	74S571	7.95
74S86	.79	74S196	3.95	74S572	19.95
74S112	.79	74S240	2.95	74S573	19.95
74S113	.79	74S241	2.95	74S940	3.15
74S114	.79	74S242	3.25	74S941	3.15

CA–LINEAR

CA3010H	1.07			CA3089N	3.75
CA3013H	2.15	CA3060N	3.25	CA3096N	3.95
CA3023H	3.25	CA3080H	1.25	CA3130H	1.39
CA3035H	2.48	CA3081N	2.00	CA3140H	1.25
CA3039H	1.35	CA3082N	2.00	CA3160H	1.25
CA3046N	1.30	CA3083N	1.60	CA3401N	.59
CA3059N	3.25	CA3086N	.85	CA3600N	3.50

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CD4000	.39			CD 4098	2.49
CD4001	.39	CD4041	1.49	CD4506	.75
CD4002	.39	CD4042	.99	CD4507	.99
CD4006	1.19	CD4043	.89	CD4508	3.95
CD4007	.25	CD4044	.89	CD4510	1.39
CD4009	.49	CD4046	1.79	CD4511	1.29
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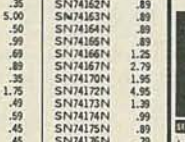
CD4011	.39	CD4048	1.35	CD4514	3.95
CD4012	.25	CD4049	.49	CD4515	2.95
CD4013	.49	CD4050	.69	CD4516	1.49
CD4014	1.39	CD4051	1.19	CD4518	1.79
CD4015	1.19	CD4052	1.19	CD4519	.89
CD4016	.59	CD4053	1.19	CD4520	1.29
CD4017	1.19	CD4056	2.95	CD4526	1.79
CD4018	.99	CD4059	9.95	CD4528	1.79
CD4019	.49	CD4060	1.49	CD4529	1.95
CD4020	1.19	CD4066	.79	CD4543	2.79
CD4021	1.39	CD4068	.39	CD4562	11.95
CD4022	1.19	CD4069	.45	CD4566	2.79
CD4023	.29	CD4070	.55	CD4583	2.49
CD4024	.79	CD4071	.49	CD4584	.75
CD4025	.23	CD4072	.49	CD4723	1.95
CD4026	2.95	CD4073	.39	CD4724	1.95
CD4027	.69	CD4075	.39	MC14409	14.95
CD4028	.89	CD4076	1.39	MC14410	14.95
CD4029	1.49	CD4078	.55	MC14411	14.95
CD4030	.49	CD4081	.39	MC14412	11.95
CD4034	3.49	CD4082	.39	MC14419	4.95
CD4035	.99	CD4093	.99	MC14433	13.95
CD4040	1.49			MC14538	2.49
				MC14541	1.95

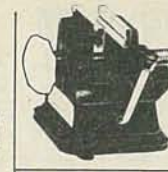
DIP/IC INSERTION TOOL WITH PIN STRAIGHTENER



Inserts both 14 and 18 pin packages. Narrow profile permits work on closely spaced items. Pin straightener built into handle.

Part No.	Function	Price
INS-1416	14-16 pin	$3.49
MOS-1416	14-16 pin CMOS safe	7.95
MOS-2428	24-28 pin CMOS safe	7.95
MOS-40	36-40 pin CMOS safe	7.95

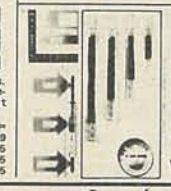
Vacuum Vise



Vacuum-based light-duty vise for small components and assemblies. ABS construction, 1½" jaws, 1¼" travel. Can be permanently installed.

VV-1.....$3.49

Wire Wrapping Kit WK-2



Contains WSU-30 wrap tool, 50 feet of Kynar 30 AWG white wire, 50 pieces each pre-stripped wire in 1", 2" 3" and 4" lengths, stripped 1" both ends.

WK-2.....$12.95

DISCRETE LEDS

XC556R	.200" red	5/$1	MV50	.085" red	6/$1
XC556G	.200" green	4/$1	XC209R	.125" red	5/$1
XC556Y	.200" yellow	4/$1	XC209G	.125" green	4/$1
XC556C	.200" clear	4/$1	XC209Y	.125" yellow	4/$1
XC22R	.200" red	5/$1	XC526R	.185" red	5/$1
XC22G	.200" green	4/$1	XC526G	.185" green	4/$1
XC22Y	.200" yellow	4/$1	XC526Y	.185" yellow	4/$1
MV10B	.170" red	4/$1	XC526C	.185" clear	4/$1

6 VOLT MINI LAMP

– INCANDESCENT –

800-147 Clear w/5" leads 8/$1
80620 Red w/10" leads 9/$1

XC194 RED LED, METAL MTG. HDW, 2-4" LEADS.

RL-2 . . $.39 ea. or 3/$1.00

DISPLAY LEDS

C.A. — Common Anode

Type	Polarity	Ht	Price
MAN 1	C.A.–red	.270	2.95
MAN 2	5x7 D.M.–red	.300	4.95
MAN 3	C.C.–red	.125	.25
MAN 52	C.A.–green	.300	1.25
MAN 54	C.C.–green	.300	1.25
MAN 71	C.A.–red	.300	.75
MAN 72	C.A.–red	.300	.75
MAN 74	C.C.–red	.300	1.25
MAN 82	C.A.–yellow	.300	.49
MAN 84	C.C.–yellow	.300	.99
MAN 3620	C.A.–orange	.300	.49
MAN 3630	C.A.–orange ± 1	.300	.99
MAN 3640	C.C.–orange	.300	.99
MAN 4610	C.A.–orange	.400	.99
MAN 6610	C.A.–orange–DD	.560	.99
MAN 6630	C.A.–orange ± 1	.560	.99
MAN 6640	C.C.–orange–DD	.560	.99
MAN 6650	C.C.–orange ± 1	.560	.99
MAN 6660	C.A.–orange	.560	.99
MAN 6710	C.A.–red–DD	.560	.99
MAN 6750	C.C.–red ± 1	.560	.99
MAN 6780	C.C.–red	.560	.99
DLO304	C.C.–orange	.300	1.25
DLO307	C.A.–orange	.300	1.25
DLG500	C.C.–green	.500	1.25

C.C. — Common Cathode

Type	Polarity	Ht	Price
DLG507	C.A.–green	.500	1.25
DL704	C.C.–red	.300	1.25
DL707	C.A.–red	.300	1.25
DL728	C.C.–red	.500	1.49
DL741	C.A.–red	.600	1.25
DL746	C.A.–red ± 1	.630	1.49
DL747	C.A.–red	.600	1.49
DL750	C.C.–red	.600	1.49
DLO847	C.A.–orange	.800	1.49
DLO850	C.C.–orange	.800	1.49
DL33B	C.C.–red	.110	.35
FND358	C.C. ± 1	.357	.99
FND359	C.C.	.357	.75
FND503	C.C. (FND500)	.500	.99
FND507	C.A. (FND510)	.500	.99
HDSP-3401	C.A.–red	.800	1.50
HDSP-3403	C.C.–red	.800	1.50
5082-7751	C.A.,R.H.D.–red	.430	1.25
5082-7760	C.C.,R.H.D.–red	.430	1.75
5082-7300	4x7 sgl. dig. RHD	.600	22.00
5082-7302	4x7 sgl. dig. LHD	.600	22.00
5082-7304	Overnge. char. (±1)	.600	19.95
4N28	Photo Xsistor Opto-Isol.	.99	
LIT-1	Photo Xsistor Opto-Isol.	.69	
MOC3010	Optically Isol.Triac Driver	1.25	

SOCKETS — RECEPTACLES

Test Sockets (TEXTOOL)

ZERO INSERTION FORCE

* Nickel Boron Plating
* G.F. PSF Plastic Body
* For testing IC's

Part No.	Pins	Price
214-3339	14 pin	5.95
216-3340	16 pin	6.49
218-3341	18 pin	7.95
220-3342	20 pin	8.95
222-3343	28 pin	9.95
224-3344	24 pin	9.75
228-3345	28 pin	11.95
240-3346	40 pin	12.95

* Nickel Boron Plating
* G.F. PSF Plastic Body
* Wire Wrap Contacts

Part No.	Pins	Price
214-3592	14 pin	9.75
216-3593	16 pin	9.95
218-3594	18 pin	10.95
220-3595	20 pin	11.95
222-3596	22 pin	12.95
224-3597	24 pin	12.75
228-3598	28 pin	13.95
240-3599	40 pin	15.95

LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100
8 pin LP	.17	.16	.15
14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.37	.36	.35
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
36 pin LP	.60	.59	.58
40 pin LP	.63	.62	.61

SOLDERTAIL (GOLD) STANDARD

	1-24	25-49	50-100
8 pin SG	.39	.35	.31
14 pin SG	.49	.45	.41
16 pin SG	.54	.49	.44
18 pin SG	.59	.53	.48
24 pin SG	.79	.75	.69
28 pin SG	1.10	1.00	.90
36 pin SG	1.65	1.40	1.26
40 pin SG	1.75	1.59	1.45

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100
14 pin ST	.27	.25	.24
16 pin ST	.30	.27	.25
18 pin ST	.35	.32	.30
24 pin ST	.49	.45	.42
28 pin ST	.99	.90	.81
36 pin ST	1.39	1.26	1.15
40 pin ST	1.59	1.45	1.30

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100
8 pin WW	.59	.54	.49
10 pin WW	.69	.63	.58
14 pin WW	.79	.73	.67
16 pin WW	.85	.77	.70
18 pin WW	.99	.90	.81
20 pin WW	1.19	1.08	.99
22 pin WW	1.49	1.35	1.23
24 pin WW	1.39	1.26	1.14
28 pin WW	1.69	1.53	1.38
36 pin WW	2.19	1.99	1.79
40 pin WW	2.29	2.09	1.89

INTERSIL

Part No.	Function	Price
7045IPI	CMOS Precision Timer	14.95
7045EV/Kit*	Stopwatch Chip, XTL	22.96
7106CPL	3½ Digit A/D (LCD Drive)	16.95
7106EV/Kit*	IC, Circuit Board, Display	34.95
7107CPL	3½ Digit A/D (LED Drive)	15.96
7107EV/Kit*	IC, Circuit Board, Display	28.95
7116CPL	3½ Digit A/D LCD Dis. HLD.	18.95
7117CPL	3½ Digit A/D LED Dis. HLD.	17.95
7201IDR	Low Battery Volt Indicator	2.25
7205IPG	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	Stopwatch Chip, XTL	19.96
7206CJPE	Tone Generator	5.15
7206CEV/Kit*	Tone Generator Chip, XTL	9.95
7207AIPD	Oscillator Controller	6.50
7207AEV/Kit*	Freq. Counter Chip, XTL	11.10
7208IPI	Seven Decade Counter	17.95
7209IPA	Clock Generator	3.95
7215IPG	4 Func. CMOS Stopwatch CKT	13.95
7215EV/Kit*	4 Func. Stopwatch Chip, XTL	19.96
7216AIJI	8-Digit Univ. Counter C.A.	32.00
7216CIJI	8-Digit Freq. Counter C.A.	26.96
7216DIPI	8-Digit Freq. Counter C.C.	21.95
7217IJI	4-Digit LED Up/Down Counter	12.95
7218CIJI	8-Digit Univ. LED Drive	10.96
7224IPL	LCD 4½ Digit Up Counter DRI	11.25
7226AIJL	8-Digit Univ. Counter	31.95
7226AEV/Kit*	5 Function Counter Chip, XTL	74.95
7240IJE	CMOS Bin Prog. Timer/Counter	4.95
7242IJA	CMOS Divide-by-256 RC Timer	2.05
7250IJE	CMOS BCD Prog. Timer/Counter	6.00
7260IJE	CMOS BCD Prog. Timer/Counter	5.25
7555IPA	CMOS 555 Timer (8 pin)	1.45
7556IPD	CMOS 556 Timer (14 pin)	2.20
7611BCPA	CMOS Op Amp Comparator 5MV	2.25
7612BCPA	CMOS Op Amp Ext. Cmvr. 5MV	2.95
7621BCPA	CMOS Dual Op Amp Comp. 5MV	3.96
7631CCPE	CMOS Tri Op Amp Comp. 10MV	5.35
7641CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7642CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7660CPA	Voltage Converter	2.95
8038CCPD	Waveform Generator	4.95
8048CCPE	Monolithic Logarithmic Amp	21.60
8069CCQ	50ppm Band–GAP Volt Ref. Diode	2.50
8211CPA	Volt Ref/Indicator	2.50
8212CPA	Volt Ref/Indicator	2.50

74C

74C00	.39			74C221	1.95
74C02	.39	74C95	1.59	74C240	2.25
74C04	.39	74C107	1.89	74C244	2.25
74C08	.39	74C151	2.95	74C373	3.49
74C10	.39	74C154	3.95	74C374	2.59
74C14	.75	74C157	2.25	74C901	.89
74C20	.39	74C160	1.69	74C903	1.15
74C30	.39	74C161	1.60	74C911	10.95
74C42	1.39	74C162	1.49	74C912	10.95
74C48	1.95	74C163	1.69	74C915	1.69
74C73	.79	74C164	1.59	74C917	10.95
74C74	.79	74C173	1.39	74C922	5.49
74C85	1.95	74C174	1.39	74C923	5.75
74C86	.99	74C175	1.39	74C925	7.50
74C89	6.95	74C192	1.69	74C926	7.50
74C90	1.29	74C193	1.69	80C95	.79
74C93	1.29	74C195	1.59	80C97	.79

LH0002CN	6.85			LM702H	.79
LM10CLH	4.50	LM340T-5	1.25	LM703CN	.89
LM11CLH	4.75	LM340T-12	1.25	LM709N	.49
LH0070-0H	6.05	LM340T-15	1.25	LM710N	.79
TL071CP	.79	LM341P-5	.75	LM711N	.79
TL072CP	1.39	LM341P-12	.75	LM723N	.69
TL074CN	2.49	LM341P-15	.75	LM733N/H	1.00
LH0082CD	35.80	LM342P-5	.69	LM739N	1.19
TL082CP	1.19	LM342P-12	.69	LM741CN	.35
TL084CN	2.19	LM342P-15	.69	MC1741SCG	3.00
LH0094CD	36.80	LM348N	1.25	LM747N/H	.79
LM300H	.99	LM350K	5.75	LM748N/H	.59
LM301CN/H	.35	LM351N	.60	LM1014N	2.75
LM301N	1.95	LM353N	1.00	LM1310N	1.95
LM304H	1.95	LM356N	1.10	LM1458CN	.69
LM305H	.99	LM356N	1.10	LM1488N	1.25
LM307CN/H	.45	LM356N	1.10	LM1489N	1.25
LM308CN/H	1.00	LM358N	1.00	LM1496N	1.95
LM309H	1.95	LM359N	1.79	LM1556V	1.75
LM309K	1.25	LM370N	4.49	LM1800N	2.95
LM310CN	1.75	LM373N	3.25	LM1877N-9	3.25
LM311H/CN	.90	LM377N	2.95	LM1889N	3.20
LM312H	2.49	LM380N	1.25	LM1896N	1.75
LM317MP	1.15	LM381N	1.95	LM2002T	1.49
LM317T	1.75	LM382N	1.79	LM2877P	2.05
LM317K	3.95	LM384N	1.95	LM3878P	2.25
LM318CN/H	1.95	LM386N-3	1.29	LM2896P-1	2.25
LM319N	1.95	LM387N	1.45	LM3189N	2.95
LM320K-5	1.35	LM389N	1.35	LM3900N	.69
LM320K-12	1.35	LM392N	.69	LM3905CN	1.25
LM320K-15	1.35	LF398N	4.00	LM3909N	1.15
LM320T-5	1.25	LM399H	5.00	LM3914N	3.95
LM320T-12	1.25	TL494CN	4.49	LM3915N	3.95
LM320T-15	1.25	TL496CP	1.75	LM3916N	3.95
LM323K-5	5.95	NE510A	6.00	RC4136N	1.25
LM324N	.99	NE529A	4.95	RC4151NB	5.95
LM329DZ	.65	NE531H	3.95	RC4194TK	5.95
LM331N	3.95	NE536H	6.00	RC4195TK	5.49
LM334Z	1.30	NE540H	6.00	KB4428	4.25
LM335Z	1.40	NE544N	4.95	KB4429	5.95
LM336Z	1.75	NE550A	1.30	LM4500A	3.25
LM337T	1.95	NE555V	.39	ICL8038B	4.95
LM337MP	1.15	LM556N	.99	LM13080N	1.29
LM338K	6.95	NE564N	3.95	LM13600N	1.49
LM339N	.99	LM565N	1.25	75138N	1.95
LM340K-5	1.35	LM566CN	1.95	75450N	.89
LM340K-12	1.35	LM567V	1.25	75451CN	.39
LM340K-15	1.35	NE570N	4.95	75492	.89

1/4 WATT RESISTOR ASSORTMENTS – 5%

ASST. 1	5ea.	10 Ohm 12 Ohm 15 Ohm 18 Ohm 22 Ohm 27 Ohm 33 Ohm 39 Ohm 47 Ohm 56 Ohm		50pcs.	$1.95
ASST. 2	5ea.	68 Ohm 82 Ohm 100 Ohm 120 Ohm 150 Ohm 180 Ohm 220 Ohm 270 Ohm 330 Ohm 390 Ohm		50pcs.	$1.95
ASST. 3	5ea.	470 Ohm 560 Ohm 680 Ohm 820 Ohm 1K 1.2K 1.5K 1.8K 2.2K 2.7K		50pcs.	$1.95
ASST. 4	5ea.	3.3K 3.9K 4.7K 5.6K 6.8K 8.2K 10K 12K 15K 18K		50pcs.	$1.95
ASST. 5	5ea.	22K 27K 33K 39K 47K 56K 68K 82K 100K 120K		50pcs.	$1.95
ASST. 6	5ea.	150K 180K 220K 270K 330K 390K 470K 560K 680K 820K		50pcs.	$1.95
ASST. 7	5ea.	1M 1.2M 1.5M 1.8M 2.2M 2.7M 3.3M 3.9M 4.7M 5.6M		50pcs.	$1.95
ASST. 8R		Includes Resistor Assts. 1-7 (350 pcs.)			$10.95 ea.

$10.00 Min. Order — U.S. Funds Only
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8/81

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

Value	1-9	10-99	100+	Value	1-9	10-99	100+
10 pf	.08	.06	.05	.001µF	.08	.06	.05
22 pf	.08	.06	.05	.0047µF	.08	.06	.05
47 pf	.08	.06	.05	.01µF	.08	.06	.05
100 pf	.08	.06	.05	.022µF	.09	.07	.06
220 pf	.08	.06	.05	.047µF	.09	.07	.06
470 pf	.08	.06	.05	.1µF	.15	.12	.10

100 VOLT MYLAR FILM CAPACITORS

.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022mf	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+20% DIPPED TANTALUMS (Solid) CAPACITORS

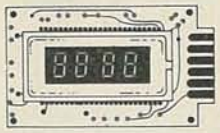
.1/35V	.39	.34	.29	1.5/25V	.41	.37	.29
.15/35V	.39	.34	.29	2.2/35V	.51	.45	.34
.22/35V	.39	.34	.29	3.3/25V	.53	.47	.37
.33/35V	.39	.34	.29	4.7/25V	.63	.56	.45
.47/35V	.39	.34	.29	6.8/25V	.79	.69	.55
.68/35V	.39	.34	.29	15/25V	1.39	1.25	.95
1.0/35V	.39	.34	.29	22/6V	.79	.69	.55

MINI. ALUMINUM ELECTROLYTIC CAPACITORS

Axial	1-99	100-499	500+	Radial	1-99	100-499	500+
.47/50V	.16	.14	.10	.47/25V	.15	.13	.12
1.0/50V	.19	.16	.12	.47/50V	.16	.14	.13
3.3/50V	.17	.15	.11	1.0/16V	.15	.13	.12
4.7/25V	.18	.15	.11	1.0/25V	.16	.14	.13
10/25V	.18	.15	.11	1.0/50V	.17	.15	.14
10/50V	.19	.16	.12	4.7/16V	.15	.13	.12
22/25V	.19	.16	.12	4.7/25V	.16	.14	.13
22/50V	.24	.20	.18	4.7/50V	.17	.15	.14
47/25V	.25	.21	.19	10/16V	.15	.13	.12
47/50V	.29	.25	.23	10/25V	.16	.14	.13
100/25V	.28	.24	.22	10/50V	.17	.15	.14
100/50V	.41	.37	.34	47/50V	.26	.21	.19
220/25V	.39	.34	.33	100/16V	.21	.17	.14
220/50V	.49	.45	.41	100/25V	.25	.23	.21
470/25V	.54	.49	.45	100/50V	.37	.34	.31
1000/16V	.79	.69	.61	220/16V	.26	.21	.19
2200/16V	.89	.79	.69	470/25V	.35	.31	.27

CIRCLE 19 ON FREE INFORMATION CARD

National Semiconductor Clock Modules



12VDC AUTOMOTIVE/ INSTRUMENT CLOCK

APPLICATIONS:
- In-dash autoclocks
- After-market auto/ RV clocks
- Aircraft-marine clks.
- 12VDC oper. instru.
- Portable/battery powered instrumnts.

Features: Bright 0.3" green display. Internal crystal time-base. ± 0.5 sec./day accur. Auto. display brightness control logic. Display color filterable to blue, blue-green, green & yellow. Complete—just add switches and lens.

MA1003 Module $16.95

CLOCK MODULES

MA1023	.7" Low Cost Digital LED Clock Module	8.95
MA1026	.7" Dig. LED Alarm Clock/Thermometer	18.95
MA5036	.3" Low Cost Digital LED Clock/Timer	6.95
MA1002	.5" LED Display Dig. Clock & Xformer	9.95

TRANSFORMERS

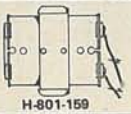
102-P20	Xformer for MA1023 Clock Modules	3.49
102-P22	Xformer for MA1026 Clock Modules	3.49
102-P20	Xformer for MA5036 Clock Modules	3.49

A0201

8 OHM SPEAKER

2¼" — 8 Ohm — .25 watt

$1.25 ea. 2/$1.95 ea. 10/$7.95 ea.

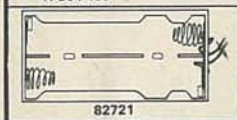


H-801-159

BATTERY HOLDER

- Holds 2 ea. C cells
- Aluminum Case
- 5" leads

$ .45 each 10/$3.95



82721

BATTERY HOLDER

- Holds 4 ea. C cells
- Plastic case
- 9" leads

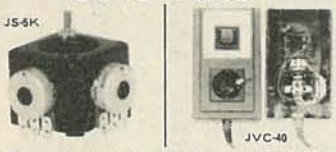
$ .49 ea. 10/$4.25

EPROM Erasing Lamp

- Erases 2708, 2716, 1702A, 5203Q, 5204Q, etc.
- Erases up to 4 chips within 20 minutes.
- Maintains constant exposure distance of one inch.
- Special conductive foam liner eliminates static build-up.
- Built-in safety lock to prevent UV exposure.
- Compact — only 7-5/8" x 2-7/8" x 2"
- Complete with holding tray for 4 chips.

UVS-11E $79.95

JOYSTICKS



JS-5K	5K Linear Taper Pots	$5.25
JS-100K	100K Linear Taper Pots	$4.95
JVC-40	40K (2) Video Controller in case	$5.95

6-Digit Clock Kit

- Bright .300 ht. comm. cathode display
- Uses MM5314 clock chip
- Switches for hours, minutes and hold modes
- Hrs. easily viewable to 20 ft.
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hr. operation
- Incl. all components, case & wall transformer
- Size: 6¾" x 3-1/8" x 1¾"

JE701 . . . . . $19.95

NEW! JE215 Adjustable Dual Power Supply

General Description: The JE215 is a Dual Power Supply with independent adjustable positive and negative output voltages. A separate adjustment for each of the supplies provides the user unlimited applications for IC current voltage requirements. The supply can also be used as a general all-purpose variable power supply.

FEATURES:
- Adjustable regulated power supplies, pos. and neg. 1.2VDC to 15VDC
- Power Output (each supply): 5VDC @ 500mA, 10VDC @ 750mA, 12VDC @ 500mA, and 15VDC @ 175mA.
- Two, 3-terminal adj. IC regulators with thermal overload protection.
- Heat sink regulator cooling
- LED "on" indicator
- Printed Board Construction
- 120VAC input
- Size: 3-1/2"w x 5-1/16"L x 2"H

JE215 Adj. Dual Power Supply Kit (as shown) . . $24.95

(Picture not shown but similar in construction to above)

JE200 Reg. Power Supply Kit (5VDC, 1 amp) . .	$14.95
JE205 Adapter Brd. (to JE200) ±5,±9 & ±12V.	$12.95
JE210 Var. Pwr. Sply. Kit, 5-15VDC, to 1.5amp.	$19.95

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES

INS8080A	CPU	6.50
D8212	8-Bit Input/Output	3.25
D8214	Priority Interrupt Control	5.95
D8216	Bi-Directional Bus Driver	3.49
D8224	Clock Generator/Driver	3.95
D8226	Bus Driver	3.49
D8228	System Controller/Bus Driver	4.95
D8238	System Controller	5.95
INS8243	I/O Expander for 48 Series	9.95
INS8250	Asynchronous Comm. Element	16.95
D8251	Prog. Comm. I/O (USART)	7.95
D8253	Prog. Interval Timer	14.95
D8255	Prog. Peripheral I/O (PPI)	9.95
D8257	Prog. DMA Control	19.95
D8259	Prog. Interrupt Control	14.95
D8275	Prog. CRT Controller	49.95
D8279	Prog. Keyboard/Display Interface	19.95
D8300	Octal Bus Receiver	6.95
D8303	System Timing Element	6.95
D8304	8-Bit Bi-Directional Receiver	3.95
D8307	8-Bit Bi-Directional Receiver	3.95
D8308	8-Bit Bi-Directional Receiver	3.95

6800/6800 SUPPORT DEVICES

MC6800	MPU	14.95
MC6802CP	MPU with Clock and RAM	19.95
MC6810API	128x8 Static RAM	4.95
MC6821	Peripheral Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	10.95
MC6830L8	1024x8-Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	6.95
MC6852	Synchronous Serial Data Adapter	6.95
MC6860	0-600bps Digital MODEM	18.95
MC6862	2400bps Modulator	12.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25

MICROPROCESSOR CHIPS

Z80 (780C)	CPU (MK3880N) (2MHz)	13.95
Z80A (780-1)	CPU (MK3880N-4) (4MHz)	15.95
CDP1802	CPU	19.95
7650	MPU	16.95
IDM2901ADC	CPU—4-Bit Slice (Com. Temp. Grade)	19.95
MC50502	MPU w/Clock (65K Bytes Memory)	11.95
INS8035N-4	MPU—8-Bit (6MHz)	16.95
INS8039N-4	CPU—Sgl. Chip 8-Bit (128 bytes RAM)	19.95
INS8040N-4	CPU (256 Bytes RAM)	24.95
INS8070N	CPU—64 Bytes RAM	24.95
INS8073N	CPU w/Basic Micro Interpreter	29.95
P8085	CPU	19.95
INS8900	CPU—16-Bit	29.95
TMS9900JL	MPU—16-Bit	49.95

SHIFT REGISTERS

MM500H	Dual 25-Bit Dynamic	.50
MM502H	Dual 50-Bit Dynamic	.50
MM506H	Dual 100-Bit Static	.50
MM510H	Dual 64-Bit Accumulator	.50
MM1402	256-Bit Dynamic	2.95
MM5013	1024-Bit Dynamic/Accumulator	1.95
MM5016H	500/512-Bit Dynamic	.89
MM5034N	Octal 80-Bit	9.95
MM5035H	Octal 80-Bit	9.95
2504V (340AA)	1024-Bit Dynamic	3.95
2518N	Hex 32-Bit Static	4.95
2522V	Dual 132-Bit Static	2.95
2524V	512-Bit Dynamic	.99
2525V	1024-Bit Dynamic	2.95
2527V	Dual 256-Bit Static	2.95
2528V	Dual 250-Bit Static	4.00
2529V	Dual 240-Bit Static	4.00
2532N	Quad 80-Bit Static	2.95
3341PC	Fifo (Dual 80)	6.95

DATA ACQUISITION

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AF121-1CJ	Touch Tone Low Pass Filter	19.95
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LM308AH	Super Gain Op Amp	1.00
LM334Z	Constant Current Source	1.30
LM335Z	Temperature Transducer	1.40
LF356N	JFET Input Op Amp	1.10
LF398N	Sample & Hold Amplifiers	3.95
LM399H	Temp. Comp. Prec. Ref. (.5ppm/C°)	4.95
ADC0804LCN	8-Bit A/D Converter (1 LSB)	4.95
DAC0806LCN	8-Bit D/A Converter (0.78% Lin.)	2.25

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ADC0817CCN	8-Bit A/D Converter (16-Ch. Multi.)	10.95
DAC1000LCN	10-Bit D/A Conv. Micro. Comp. (0.05%)	13.95
DAC1008LCN	10-Bit D/A Conv. Micro. Comp. (0.20%)	4.95
DAC1020LCN	10-Bit D/A Converter (0.05% Lin.)	8.49
DAC1022LCN	10-Bit D/A Converter (0.20% Lin.)	5.95
DAC1222LCN	12-Bit D/A Converter (0.20% Lin.)	9.95
CD4051N	8-Channel Multiplexer	1.25
AY-5-1013	30Hz BAUD UART	5.95

RAM'S

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2101 (8101)	256x4 Static	3.95
2102	1024x1 Static	1.75
211,02	1024x1 Static	1.95
2111 (8111)	256x4 Static	3.95
2112	256x4 Static MOS	4.95
2114	1024x4 Static 450ns	5.95
2114L	1024x4 Static 450ns Low Power	6.95
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2114L-3	1024x4 Static 300ns Low Power	7.95
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4116N-4 (UPD416)	16K Dynamic 250ns (MM5290N-4)	3.95
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MM2147J	4096x1 Fast 70ns	19.95
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MM5261	1024x1 Dynamic Fully Decoded	.99
MM5262	2Kx1 Dynamic	.25
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2513(3021)	Character Generator (Lower Case)	9.95
2536N	Character Generator	10.95
MM5230N	2048-Bit Read Only Memory	1.95

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MCM66750P	128x9x7 Alpha. Control Char. Gen.	13.50

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M-Z80	User Manual	7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00

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INS2651N	Communication Chip	19.95
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MM58174N	Microprocessor Compatible Clock	11.95
COP402N	Microcontroller with 64-Digit RAM and Direct LED Drive	6.95
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COP470N	32-Seg. VAC Fluor. Driver (20-pin pkg.)	3.25

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AY-5-2376	Keyboard Encoder (88 keys)	11.95
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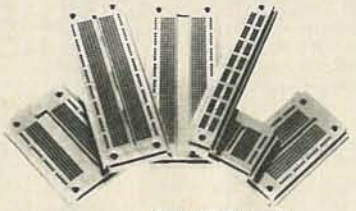

Model	Length	Width	Center Channel	5 Tie Point Terminals	Bus Strips	Price
EXP48	6.0"	1.0"	n/a	n/a	4(160)	$ 4.75
EXP300	6.0"	2.1"	.3"	94(470)	2(80)	$12.00
EXP325	1.8"	2.1"	.3"	22(110)	2(20)	$ 3.50
EXP350	3.6"	2.1"	.3"	46(230)	2(40)	$ 6.75
EXP600	6.0"	2.4"	.6"	94(470)	2(80)	$14.75
EXP650	3.6"	2.4"	.6"	46(230)	2(40)	$ 8.75

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GT-35B	4.1"	3.8"	12	$ 2.25
GT-18S	2.4"	2.1"	36	$ 4.50
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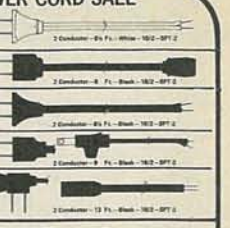

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JE610/DTE-AK (After assembled as pictured above) . . . **$124.95**

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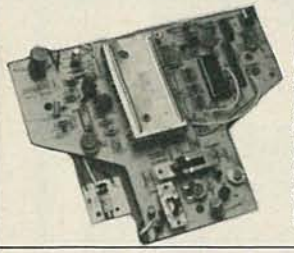
WHOLESALE/RETAIL

EQUIPMENT/COMPONENTS/WIRE & CABLE/ACCESSORIES



"TANK BATTLE" TV GAME

In just a short time and with a few minor parts, the most novice hobbiest can complete this exciting Tank Battle game. Create a fun-filled evening for the whole family. Two independent tanks rumble thru land mine fields, shoot shells and fragment when hit. Four distinct engine sounds are produced for the different speeds. Sounds of gunfire, shell bursts and tank explosions are realistic. Automatic on-screen scoring. Supplied with schematic drawing.

SOLD AS IS

$9.95 ea.

C.B. SPECIAL

CONVERT THESE TO 10 METER FM

New printed circuit board assembly. (Squelch pot, volume control and channel switch not included.) Boards sold as is, the way we bought them from the manufacturer. Board dimensions 6" x 6½".

1-9 **$7.50** 50-99 **$6.00**
10-49 **$6.50** 100-UP **$5.50**

COPPER CLAD BOARD

(Double Side)

Size 9.25 x 10.75
Thickness .062

$2.00 ea.

PANEL METERS

25-0-25 VDC, 2¼" x 3"
0-25 VDC, 2¼" x 2¼"
0-25 VAC, 2¼" x 2¼"
(Shunt required)

$4.00 ea. **2/$7.00**

E. F. JOHNSON S METER

Edge Meter 250 UA, fits in ⅝" x 1⅜" hole. Black background.

Scale 1-20 Top, 0-5 Bottom.

$1.25 ea. **5/$5.00**

E.F. JOHNSON SIGNAL STRENGTH METER

200 UA, 2½" x 2½" Sq.

Scale: 1-30 db top (orange), 0-50 bottom (black)

$4.95 ea.

DIP SWITCH

7 POSITION **$1.30** ea.
8 POSITION **$1.50** ea.
12 POSITION **$2.00** ea.

TRIMMER CAP

1.5-20pF (ARCO PC-402)

50¢ ea.

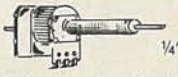
AMP METERS

2¼' square, no shunt required. Easy to read dial.

Movement: 0-6, 0-10, 0-17

$2.50 ea.

SUB-MINI 10K POT



with On-Off ¼" hole mount, ⅛" D shaft, ¾" thread section. Hardware included.

4/$1.00

COAX CONNECTORS

UG-273/U BNC-F/UHF-M	$2.50
UG-255/U BNC-M/UHF-F	$3.00
UG-146 A/U N-M/UHF-F	$4.50
UG-83B/U N-F/UHF-M	$4.50
UG-175 RG-58 Adapt	$ .20
UG-176 RG-59 Adapt	$ .20
UG-1094 BNC-F/Panel	$1.00

USED MUFFIN FANS

3-Blades, 110v AC, 4¾" square.

$5.95 ea.

ASTATIC T-UG8-D104 MICROPHONE

Pre-amp desk-top microphone with crystal element 3-pin plug.

$35.00 ea.

SO239 **.60**
PL259 **.60**
500 OHM COAX
Low loss = RG 174

$4.95/100' $3.00/50'

NEW SPRITE FAN

Mfg. by Rotron Inc., Model SU2A5. 115v AC. 19 amps. (Impedance protected.) 3¼" x 3¼" x 1¾"

$12.00 ea.

SPEAKER

3" Diam., 8 OHM, 5 Watts.

$2.00 ea.

SPEAKER

Weather & water-proof (can be used underwater), mfg. by University Sound. 16 OHM, 25 Watt, 350-10,000 HZ. 6" diam. x 5" deep.

$25.00 ea.

IC SOCKETS GOLD-PLATED WIRE WRAP

14 pin **40¢** ea.
16 pin **45¢** ea.
24 pin **75¢** ea.
40 pin **$1.75** ea.

9 VOLT NiCd RECHARGEABLE BATTERY

NEW. Replaces the popular 9V Transistor Battery.

$4.75 ea.

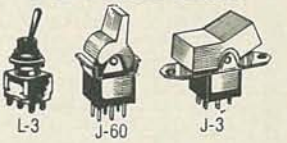
COMPUTER GRADE ELECTROLYTICS

VALUE/MFD	VOLTS	DIAM./LGTH.	PRICE
63,000	@ 15V	3" x 5½"	$4.00 ea.
10,000	@ 20V	1½" x 5¾"	$3.00 ea.
2,700	@ 25V	1¼" x 2¼"	$2.00 ea.
2,900	@ 25V	1¼" x 2"	$2.00 ea.
3,000	@ 25V	1½" x 4½"	$2.00 ea.
34,800	@ 50V	3" x 5½"	$3.00 ea.
450	@ 75V	1¼" x 2¼"	$2.00 ea.
500	@ 100V	1½" x 3¼"	$2.00 ea.
240	@ 300V	1¼" x 3¼"	$2.00 ea.
50	@ 450V	1¼" x 2"	$2.00 ea.

AXIAL LEAD ELECTROLYTIC CAPACITORS

2 uF @ 15V 12/**$1.00**
10 uF @ 15V 12/**$1.00**
20 uF @ 15V 12/**$1.00**
50 uF @ 15V 12/**$1.00**
2.2 uF @ 25V 12/**$1.00**
3.3 uF @ 25V 12/**$1.00**
1 uF @ 35V 12/**$1.00**
2 uF @ 150V 12/**$1.00**
25 uF @ 25V 15/**$2.00**
3 uF @ 50V 15/**$2.00**
5 uF @ 50V 15/**$2.00**
10 uF @ 50V 15/**$2.00**
250 uF @ 25V 10/**$2.00**
100 uF @ 50V 10/**$2.00**
50 uF @ 75V 10/**$2.00**

C & K SWITCHES



L-3 J-60 J-3

Part #		Movement
J-60	7101	SPDT
J-60	7103	SPDT (center off)
L-3	7108	SPDT (momentary)
J-3	7201	DPDT (special large rocker)

$1.00 ea. **6/$5.00**

TERMS: All material guaranteed unless otherwise stated. If you are not satisfied with our product, it may be returned within 10 days for a refund (less shipping). Please add $4.00 for shipping and handling on all orders. COD's accepted for orders totaling $50 or more. All orders shipped UPS unless otherwise specified. Florida residents please add 4% sales tax. Minimum order, $15.00. Foreign orders – US funds only, add 20% for shipping and handling.

CIRCLE 23 ON FREE INFORMATION CARD

100W CLASS A POWER AMP KIT

Dynamic Bias Class "A" circuit design makes this unit unique in its class. Crystal clear, 100 watts power output will satisfy the most picky fans. A perfect combination with the TA-1020 low T.I.M. stereo pre-amp.

Specifications:

- Output power: 100W RMS into 8-ohm 125W RMS into 4-ohm
- Frequency response: 10Hz - 100 KHz
- T.H.D.: less than 0.008%
- S/N ratio: better than 80dB
- Input sensitivity: IV max.
- Power supply: ±40V @ 5 amp
- One channel

TA-1000 KIT $51.95
Power transformer $18.00 each

REGULATED VARIABLE D.C. POWER SUPPLY KIT

Uses UA723 I.C. and 2N3055 power transistor as regulator. Output voltages can be adjusted from 0~30V at an internal resistance of less than 0.005 ohm; ripple and noise less than 1 MV; with built on board LED and audible overload indicator. Kit comes with P.C. board; all electronic components, transformer; connectors; 2 panel meters for voltage and amp; a professional look metal cabinet and instructions.

Model TR-88A 0~15V D.C. 3 amp
Model TR-88B 0~30V D.C. 2 amp

$59.50 per kit NEW

NEW WHISTLE ACTIVATED SWITCH BOARD

All boards are pre-assembled and tested. Your whistle to its FET condenser microphone from a distance, as far as 30 feet away (sensitivity can be easily adjusted) will turn the switch on, then latched you whistle to it again then it turns off. Ideal for remote control toys, electrical appliance such as lights, coffee pots, TV, Hi-Fi, radio or other projects. Unit works on 9V D.C.

Model 968 $4.50 each

SUB MINI SIZE FET CONDENSER MICROPHONE

Specification:
Sensitivity: — 65dB ± 3db
FEQ. Response: 50 Hz 8 KHz
Output Impedance: 1K ohm max.
Polar Pattern: Omni-directional
Power Supply: 1.5V 10V D.C.
Sound Pressure Level: Max. 120dB
EM4RP **$2.50** ea. or **2** for **$4.50**

NEW MARK III 9 Steps 4 Colors LED VU

Stereo level indicator kit with arc-shape display panel!!! This Mark III LED level indicator is a new design PC board with an arc-shape 4 colors LED display (change color from red, yellow, green and the peak output indicated by rose). The power range is very large, from —30dB to +5dB. The Mark III indicator is applicable to 1 watt - 200 watts amplifier operating voltage is 3V - 9V DC at max 400 MA. The circuit uses 10 LEDs per channel. It is very easy to connect to the amplifier. Just hook up with the speaker output!

IN KIT FORM $18.50

2 WATT AUDIO AMP

Pre assembled units. All you need is to hook up the speaker and the volume control. Supply voltage from 9~15V D.C. measures only 2" x 3½", making it good for portable or discrete applications. Comes with hook up data.

BUY 2 FOR **$4.99**

MARK IV 15 STEPS LED POWER LEVEL INDICATOR KIT

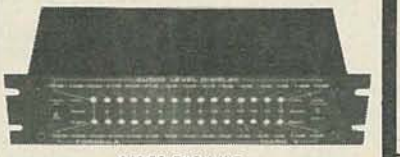
This new stereo level indicator kit consists of 36 4-color LED (15 per channel) to indicate the sound level output of your amplifier from —36dB ~ +3dB. Comes with a well-designed silk screen printed plastic panel and has a selector switch to allow floating or gradual output indicating. Power supply is 6~12V D.C. with THG on board input sensitivity controls. This unit can work with any amplifier from 1W to 200W!

Kit includes 70 pcs. driver transistors, 38 pcs. matched 4-color LED, all other electronic components, PC board and front panel.

MARK IV KIT **$31.50**

NEW MARK V 15 STEPS LED POWER OUTPUT INDICATOR KIT

All functions same as Mark IV but this is with heavy duty aluminum front plate and case. Can be easily slot into the front panel of your auto, truck or boat. Operates on 12V DC.



$41.50 EACH KIT

BATTERY POWERED FLUORESCENT LANTERN

MODEL 888 R

$10.50 EA

FEATURES

- Circuitry: designed for operation by high efficient, high power silicon transistor which enable illumination maintain in a standard level even the battery supply drops to a certain low voltage.
- 9" 6W cool/daylight miniature fluorescent tube.
- 8 x 1.5V UM-1 (size D) dry cell battery.
- Easy sliding door for changing batteries.
- Stainless reflector with wide angle increasing lumination of the lantern.

30W + 30W STEREO HYBRID AMPLIFIER KIT

Kit includes 1 PC SANYO STK-043 stereo power amp. IC LM 1458 as pre amp, all other electronic parts, PC Board, all control pots and special heat sink for hybrid. Power transformer not included. It produces ultra hi-fi output up to 60 watts (30 watts per channel) yet gives out less than 0.1% total harmonic distortion between 100MHz and 10KHz.

$32.50 PER KIT

5W AUDIO AMP KIT

2 LM 380 with Volume Control
Power Suply 6 18V DC
ONLY $6.00 EACH

TWO IN ONE PANEL METER D.C. VOLTAGE AND AMP IN ONE

D.C. Volts reads 0-50
D.C. Amp reads 0-3
Meter case made of black plastic with a white scale plate and glass window.

#ST-680 $12.50 EACH

SPECIAL 0.5" LED SALE ALARM CLOCK MODULE

ASSEMBLED! NOT A KIT!

Features: • 4 digits 0.5" LED Displays • 12 hours real time format • 24 hours alarm audio output • 59 min. countdown timer • 10 min. snooze control.

ONLY **$7.00 EACH**
SPECIAL TRANSFORMER FOR CLOCK **$2.50**

CUBO CLOCK CASES

All brand new top quality plastic cases, originally designed for Cubo clocks. Case comes with top and bottom cover with a detachable front red filter for LED readouts. This can be used for many projects such as LED CLOCK, VU METER, LIGHT BOX, FREQ. COUNTER, ETC.

3 Attractive Colors (white, lime green or orange)

BUY 3 FOR ONLY $2.50

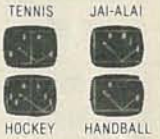
TV GAME BOARD

PLAYS 4 GAMES: TENNIS; HOCKEY; HANDBALL AND JAI-ALAI.

All boards complete with all parts ready to play. Requires 6C size batteries and a small speaker for sound effects. The boards were surplus from a famous game manufacturer. They will play on all US standard black and white or color TV sets.

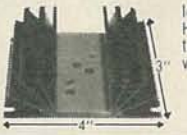
Regular price for these games were $39.50 each
OUR PRICE ONLY $6.50 EACH

PART #57456



TENNIS JAI-ALAI HOCKEY HANDBALL

MULTI-FINS HEAT SINK



Ideal for high power output. Holes predrilled for 1 to 3 transistor. Made of aluminum with ten radiating fins.

2 FOR $4.50

PROFESSIONAL FM WIRELESS MICROPHONE

TECT model WEM-16 is a factory assembled FM wireless microphone powered by an AA size battery. Transmits in the range of 88-108MHz with 3 transistor circuits and an omni-directional electric condenser. Element built-in plastic tube type case; mike is 6¼" long. With a standard FM radio, can be heard anywhere on a one-acre lot; sound quality was judged very good.

$16.50

FOR 'BOX' BUILDERS

Pre-Drilled PC Board			**$17.50**
Toriod Coils (Set of 4)			**$ 3.00**
Multi Turn Trim-Pots 10K ohm			**$ 2.50**
Trimmer Capacitor 6-35pF			**$ 0.60**
MC1358	**$ 2.50**	RC1458	**$ 1.00**
MC1350	**$ 2.00**	LM380	**$ 1.80**
MC1330	**$ 3.50**	LM340T-15	**$ 1.20**
		NE565	**$ 2.00**

We also have transformer, capacitors set, resistors set antenna transformer. Please call for price.

LCD CLOCK MODULE!

• 0.5" LCD 4 digits display • X'tal controlled circuits • D.C. powered (1.5V battery) • 12 hr. or 24 hr. display • 24 hr. alarm set • 60 min. countdown timer • On board dual back-up lights • Dual time zone display • Stop watch function.

NIC1200 (12 hr) ON SALE
NIC2400 (24 hr) $16.99 EACH

SANYO UHF VARACTOR TUNER

For UHF CH 14~83

Tuning voltage + 1V~+ 28V/D.C. Input impedance 75 OHM. I.F. band width 7~16 MHZ. Noise figure 11.5 dB MAX. Size 2⅝" x 1¼" x ¾". Supply voltage 15V D.C. Sound I.F. = 58.0 MHZ. Video I.F. = 62.5 MHZ

All units are brand new from Sanyo.
MODEL 115-B-405A
$35.00 EACH

FLUORESCENT LIGHT DRIVER KIT

12V DC POWERED
Lights up 8 ~ 15 Watt Fluorescent Light Tubes. Ideal for camper, outdoor, auto or boat. Kit includes high voltage coil, power transistor, heat sink, all other electronic parts and PC Board, light tube not included!

With Case Only $6.50 Per Kit

SUPER FM WIRELESS MIC KIT — MARK III

This new designed circuit uses high FEQ. FET transistors with 2 stages pre amp. Transmits FM Range (88-120 MHz) up to 2 blocks away and with the ultra sensitive condenser microphone that comes with the kit, allows you to pick up any sound within 15 ft. away! Kit includes all electronic parts, OSC coils, and P.C. Board. Power supply 9V D.C.

FMC-105
$11.50 PER KIT

PRESS-A-LIGHT SELF GENERATED FLASHLIGHT

EXCLUSIVE!! **$3.95 ea**
Model F-179

Never worry about battery, because it has none! Easy to carry in pocket and handy to use. Ideal for emergency light. It generates its own electricity by squeezing grip lever. Put one in your car, boat, camper or home. You may need it some time!

ELECTRONIC DUAL SPEAKER PROTECTOR

Cut off when circuit is shorted or over load to protect your amplifier as well as your speakers. A must for OCL circuits.

KIT FORM
$8.75 EA.

"FISHER" 30 WATT STEREO AMP

MAIN AMP (15W x 2)
Kit includes 2 pcs. Fisher PA 301 Hybrid IC all electronic parts with PC Board. Power supply ± 16V DC (not included). Power band with (KF 1% ± 3dB). Voltage gain 33dB. 20Hz - 20KHz.

Super Buy Only $18.50

SPACE WAR SOUND GENERATOR BOARD

Brand new preassembled module for a toy factory. The board gives out 6 different selectable space sound with LED light effect. Sounds include UFO take-off, space gun blast, wave, and space chime. 7 LED on the board will work with the sound. Requires 9V battery to operate. Speaker not included.
SPECIAL **$3.99** EACH SPEAKER **$1.25** EACH

ELECTRONIC PIEZO BEEP BUZZER

Unique surplus ⅞" Dia. piezo ceramic disc on circuit board gives a distinct high freq. buzz. Unit contains an I.C., 2 caps, 6 resistors and is already preassembled. Requires 9V battery to operate.
SPECIAL 2 FOR **$2.99**

2 BIT COUNTER, WARBLE PULSE ALARM BOARD

This new assembly easily converts to a counter, stop watch, warble and pulse alarm generator by adding a few components. We supply the data and typical applications. Requires 9V battery to operate.
SPECIAL 2 FOR **$1.99**

AUDIO OUTPUT dB METER

Meter made of clear plastic with a silver white face plate. Scale reads from −20 +3dB. Meter also comes with an internal dial light.

MODEL: 6F-3
$6.50 EACH

BATTERIES

PK/$10.00
2 PKS/$19.00

NICKEL CADMIUM BATTERY PACK 'D' SIZE

ILLUSTRATED LESS COVER

Output: 3.6 Volts @ 3.0 Amp/Hour. Consists of three each, 1.2 Volt "D" size Nickel Cadmium Cells stacked and plastic film encapsulated. Tabs are provided at each end for electrical connections. The individual cells can be cut apart if desired. Rated recharge rate is 30 mA, 14-18 hours. Size: 1¼" dia. x 7" long. New. Shpg. Wt. each pack, 1 lb.

9V RECHARGEABLE NI-CD BATTERY

Replace all 006P type 9V battery
Model: GC9
BRAND NEW **$4.50 EACH**

NI-CD BATTERY SALE

12V Pack 450 MZ/HR Size 3" x 1" x 2"
$8.00 PER PACK

4 AA Pack 450 MA/HR
$3.50 PER PACK

All above batteries are used but late date code and we guarantee to take back all bad ones for exchange.

GELCELL 6V 9AMP/HR SEALED LEAD ACID RECHARGEABLE BATTERY

Sealed construction permits this battery to be operated in any position. Recharge rate 2.15 amp max. for 14-16 hours. All brand new. Limited quantities. Size of battery 4⅛" x 2¾" x 5½".

$16.50 each

ELECTRONIC PIN BALL MACHINE

That sounds and plays like the real thing. All units are brand new but without the case. Functions of the game include double flipper control, kicker control, 1-4 players, 3 speed ball control, tilt switch, automatic score, extra bonus cave and many more. All solid state with LED panel, no moving parts. Requires 9V battery to operate, speaker not included.

A perfect gift for yourself or friends.
SPECIAL **$8.99** EACH
SPEAKER **$1.25** EACH

ULTRASONIC SWITCH KIT

Kit includes the Ultra Sonic Transducers, 2 PC Boards for transmitter and receiver. All electronic parts and instructions. Easy to build and a lot of uses such as remote control for TV, garage door, alarm system or counter. Unit operates by 9-12 DC. **$15.50**

TOUCH TONE TYPE SLIM TELEPHONE KEY PAD

KEY 330

Weather proof plastic one piece keytops. Key numbers from 1-0. All switches momentary. Open one side not connected one side common. **$3.50 EACH**

SOUND ACTIVATED SWITCH

All parts completed on a PC Board SCR will turn on relay, buzzer or trigger other circuit for 2 - 10 sec. (adjustable). Ideal for use as door alarm, sound controlled toys and many other projects. Supply voltage 4.5V 9V D.C.

$1.75 ea. **2 for $3.00**

REGULATED DUAL VOLTAGE SUPPLY KIT

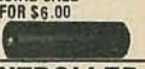
±4 30V DC 800 MA adjustable, fully regulated by Fairchild 78MG and 79MG voltage regulator I.C. Kit includes all electronic parts, filter capacitors, I.C., heat sinks and P.C. board.

$12.50 PER KIT

AA SIZE NI-CD

SPECIAL SALE 4 FOR $6.00

RECHARGEABLE BATTERIES
LIMITED QUANTITY AVAILABLE



CRYSTAL CONTROLLED WIRELESS MICROPHONE SYSTEM

No FCC license required.
OUR PRICE $49.50
ADDITIONAL MIRCOPHONE (TRANSMITTER) AVAILABLE AT $28.00 EACH

MURA WMS-49

Transmitter: FET mic for flat 30~18 KHz response extra controlled 49 MHz AM Band for drift-free performance. 100 MW output (range approx. ¼ mile) for reliable long range transmission. Powered by a 9V radio battery (included).

Receiver: Extra controlled locks on 49 MHz transmitter signal. With on panel VU meter monitors the signal strength from the microphone. Standard phone jack outlet connection to a P.A. or other phone input. 9V battery included. This professional set is ideal for on stage, in field, church, in house or outdoor use.

POWER SUPPLY KIT

0-30V D.C. REGULATED
Uses UA723 and ZN3055 Power TR output can be adjusted from 0-30V, 2 AMP. Complete with PC board and all electronic parts.

Transformer for Power Supply, 2 AMP 24V x 2 **$8.50**

0-30 Power Supply **$10.50 each**

FLASHER LED

Unique design combines a jumbo red LED with an IC flasher chip in one package. Operates directly from 5V-7V DC. No dropping resistor neded. Pulse rate 3Hz @ 5V 20mA.

2 for $2.20

BIPOLAR LED RED/GREEN

2 colors in one LED, green and red, changes color when reverse voltage supply. Amazing!
2 FOR $2.20

ELECTRONIC SWITCH KIT

CONDENSER TYPE
Touch On Touch Off uses 7473 I.C. and 12V relay
$5.50 each

1 WATT AUDIO AMP

All parts are pre-assembled on a mini PC Board. Supply Voltage 6 9V D.C. **SPECIAL PRICE $1.95 ea.**

LOW TIM DC STEREO PRE-AMP KIT TA-10 20

Incorporates brand-new D.C. design that gives a frequency response from OHz — 100KHz ±0.5dB! Added features like tone defeat and loudness control let you tailor your own frequency supplies to eliminate power fluctuation!

Specifications: • T.H.D. less than .005% • T.I.M. less than .005% • Frequency response: DC to 100KHz ±0.5dB • RIAA deviation: ±0.2dB • S/N ratio: better than 70dB • Sensitivity: Phono 2MV 47K/Aux. 100MV 100K • Output level: 1.3V • Max. output: 15V • Tone control: bass ±10dB @ 50Hz/treble ±10dB @ 15Hz • Power supply: ±24 D.C. @ 0.5A

Kit comes with regulated power supply, all you need is a 48V C.T. transformer @ 0.5A.

ONLY $44.50
X'former
$4.50 ea.

FORMULA INTERNATIONAL INC.

8/81

	SHIPPING AND HANDLING CHARGES Under $50.00 purchase	Over $50.00 purchase
Inside California	10%	5%
Outside Calif. (Includes Mexico & Canada)	15%	10%
Overseas	25%	20%

Minimum Order $10.00/Calif. Residents Add 6% Sales Tax
Phone Orders Accepted on Visa or MC ONLY, NO C.O.D./Store Hours 10-7 Mon. thru Sat.

Send $1.00 For Detailed Catalogue

11603 CRENSHAW BLVD., HAWTHORNE, CA 90250
PHONE: (213) 973-1921 • (213) 679-5162

CIRCLE 17 ON FREE INFORMATION CARD

CPU'S & SUPPORT CHIPS

8080A	4.40	8226	2.75
8085A	7.50	8228	4.50
AMD 2901	8.95	8251	5.50
8212	2.25	8259	6.95
8214	3.60	8257 (AM9617)	7.95
8216	2.90	Z80A S.10	12.95
8224	3.25	8275	16.95
	FD1791	34.95	

RAM's

2114L-3	2.75
4116-3	3.00
4116-2	3.50
21L02-3	.90
2102-4	.80
MK4027-3	3.50
MK4096-11	2.95
TMS4045-25	4.50
MS4050NL	3.95
2101-1	2.45
2107B/5280	1.75
MM5270	3.45
MK4006P	1.95
IM7001	6.95

ROM's

2708	5.95
2716	7.95
2716 + 5V	7.50
2732	16.95
82S23	2.95
82S112	7.95
82S115	6.95
82S123	4.95
82S129	3.25
82S130	3.45
82S131	3.95
AM9218C	6.95
82S181	7.75
8256-5 (74188A)	1.25

UART's

AY5-1013	3.75	M8868A	8.95
TR1602B	3.95	COM2017	3.75
PT1482B	3.25	AY3-8500	1.95
	AY3-8700	2.25	

INTERFACE & DRIVERS

1488	.90
1489	1.10
8130	2.50
8830	2.50
8833	2.50
8834	2.00
8837	2.00
8838	2.00
8T380	2.00

SHIFT REGISTERS

MM1402	1.75
MM1403	1.75
MM1404	1.75
MM5013	2.50
MM5016	2.50
MM5055	2.50
MM5056	2.50
MM5057	2.50
MM5058	2.50
MM5060	2.50

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16 PIN HEADERS	.40
24 PIN HEADERS	.75
40 PIN HEADERS	1.10
50 PIN EDGEBOARD CONN.	3.95
26 PIN EDGEBOARD CONN.	2.50
50 PIN RIGHT ANGLE CONN.	3.95
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INTERSIL ICL 7104-12 CPL 12 BIT A/D CONVERTER	$26.50
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74S00	.30	74S74	.70	74S158	1.25
74S02	.30	74S86	.80	74S160	1.75
74S03	.30	74S89	3.50	74S162	1.75
74S04	.40	74S112	.85	74S174	1.40
74S05	.45	74S133	1.40	74S175	1.40
74S08	.40	74S135	1.50	74S194	1.10
74S10	.30	74S138	1.25	74S257	1.50
74S11	.35	74S139	1.10	74S258	1.40
74S15	.40	74S140	1.00	74S260	1.50
74S20	.40	74S153	1.10	74S280	1.50
74S30	.40	74S151	1.25	74S373	2.25
74S32	.40	74S157	1.25		

7 WATT LD 65 LASER DIODE IR $8.95

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Si 1020 G	20 WATTS .$12.50
Si 1050 G	50 WATTS .$27.50

200 PRV 1A LASCR .95

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4001	.20	4027	.40	4081	.20	74C74	.50				
4002	.20	4028	.55	4082	.20	74C76	.70				
4006	.65	4029	.75	4093	.80	74C83	1.30				
4007	.27	4030	.35	4099	1.75	74C85	1.40				
4008	.65	4034	2.25	4501	.55	74C86	.50				
4009	.45	4035	.75	4510	.65	74C90	.90				
4010	.45	4040	.65	4511	.65	74C93	.95				
4011	.20	4042	.55	4514	1.40	74C151	1.75				
4012	.20	4043	.55	4515	1.50	74C157	1.75				
4013	.30	4044	.55	4516	.75	74C160	1.20				
4014	.55	4046	.90	4518	1.25	74C161	1.15				
4015	.55	4047	.90	4520	.70	74C163	1.15				
4016	.30	4049	.40	4553	2.75	74C165	1.25				
4017	.60	4050	.40	74C00	.27	74C173	1.30				
4018	.50	4051	.80	74C02	.27	74C174	1.30				
4019	.45	4052	.75	74C08	.30	74C175	1.20				
4020	.70	4053	.75	74C10	.27	74C192	1.30				
4021	.55	4066	.50	74C14	1.20	74C901	.50				
4022	.80	4068	.30	74C20	.27	74C926	5.50				
4023	.25	4071	.25	74C32	.45						
4024	.45	4072	.30	74C73	.75						
4025	.25	4075	.55								
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2N4906 PNP SI TO-3	$1.00		
2N3137 NPN SI RF	$ .55		
2N3918 NPN SI TO-3 RF	$1.50		
2N1420 NPN SI TO-5	3/$1.00		
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2N2907 PNP SI TO-18	5/$1.00		
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7403	.17	7476	.40	74173	.75
7404	.24	7480	.45	74174	.65
7405	.24	7483	.50	74175	.60
7406	.33	7485	.65	74176	.75
7407	.35	7486	.42	74177	.75
7408	.27	7490	.45	74180	.75
7409	.24	7491	.45	74181	1.90
7410	.17	7492	.45	74182	.45
7411	.22	7493	.45	74190	.70
7413	.42	7494	.60	74191	.75
7414	.50	7495	.60	74192	.70
7416	.33	7496	.60	74193	.79
7417	.37	74107	.35	74194	.85
7420	.17	74121	.35	74195	.45
7425	.30	74122	.39	74196	.75
7426	.33	74123	.42	74197	.75
7427	.30	74125	.45	74279	.60
7430	.17	74126	.45	74365	.65
7432	.27	74145	.75	74367	.65
7437	.27	74150	1.10	74368	.65
7438	.27	74151	.50	74390	.90
7440	.17	74153	.40	75324	2.25
7441	.85	75154	1.10	74325	1.50
7442	.45	74155	.50	75491	1.05
7445	.70	74157	.50	75492	1.05
7446	.75	74160	.85	8T96	.20
7447	.65	74161	.65	9312	.60
7448	.75	74162	.60	9601	.75
7450	.17	74163	.60	9602	.75
7472	.35	74164	.60		

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200	.70	.80	1.90	9.00
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600		1.80	3.60	15.00

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100	.45	.80	1.55
200	.84	1.30	2.10
400	1.30	1.90	3.10
600	2.00	2.75	4.30

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200	.07	.20	.40	1.30	5.25	9.00
400	.09	.25	.65	1.50	6.50	12.00
600	.11	.30	.80	2.00	8.50	15.00
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FND803 .8" CC	$1.95
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400	1.00	1.65	3.30
600	1.30	1.90	4.40

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14 PIN	.20	24 PIN	.35
16 PIN	.22	28 PIN	.40
18 PIN	.25	40 PIN	.60

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74LS01	.18	74LS96	.55	74LS197	.85
74LS02	.20	74LS109	.38	74LS221	.80
74LS03	.39	74LS112	.38	74LS240	.95
74LS04	.22	74LS113	.45	74LS241	.95
74LS05	.22	74LS114	.55	74LS242	.95
74LS08	.29	74LS123	.65	74LS243	1.00
74LS09	.22	74LS125	.50	74LS244	1.35
74LS10	.20	74LS126	.50	74LS245	1.80
74LS11	.22	74LS132	.50	74LS247	.75
74LS12	.22	74LS136	.45	74LS248	1.10
74LS13	.45	74LS138	.55	74LS251	.90
74LS14	.40	74LS139	.55	74LS253	.55
74LS15	.35	74LS151	.40	74LS257	.70
74LS20	.18	74LS153	.40	74LS258	.60
74LS21	.18	74LS156	1.19	74LS259	1.50
74LS22	.25	74LS157	.55	74LS266	.45
74LS26	.35	74LS158	.50	74LS273	1.15
74LS27	.28	74LS160	.70	74LS279	.50
74LS28	.45	74LS161	.70	74LS280	1.80
74LS30	.18	74LS162	1.00	74LS283	.80
74LS32	.35	74LS163	.70	74LS290	.75
74LS37	.30	74LS164	.70	74LS293	.40
74LS38	.30	74LS168	1.25	74LS365	.65
74LS40	.40	74LS169	1.75	74LS366	.65
74LS42	.44	74LS170	1.70	74LS367	.70
74LS47	.65	74LS173	.65	74LS368	.70
74LS51	.20	74LS174	.45	74LS373	1.30
74LS54	.20	74LS175	.40	74LS374	1.35
74LS73	.35	74LS181	2.00	74LS377	1.40
74LS74	.35	74LS190	.80	74LS386	.50
74LS75	.35	74LS191	.80	74LS390	1.35
74LS76	.45	74LS192	.70	74LS393	1.25
74LS83	.75	74LS193	.90	74LS670	2.50
74LS85	.85	74LS194	1.10	81LS98	1.10
74LS86	.40	74LS195	.90		
74LS90	.45				
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LM301/748	.30	LM358	.80	711CH	.40
741CV	.35	LM361	1.75	733	.95
741C	.35	LM377	1.60	LM1808	1.75
747	.50	LM380	1.25	LM1889	1.95
1456	.80	LM382	.80	CA758	1.75
1458	.50	LM383	2.50	CA3018	1.95
4136	.85	LM386	.80	CA3046	.85
3900	.45	LM387	1.25	CA3076	1.50
LM307	.30	LM553	2.25	CA3080	.95
LM308	.75	LM555	.45	CA3089	.95
LM324	.85	LM556	.85	CA3094	2.25
LM339	.65	565	.95	CA3140	1.25
LF356	1.25	567	.85	LM2901	.55
LF398	1.35	702	.95	8038CC	3.90
LM311	.50	703	.85	NS596A	1.50
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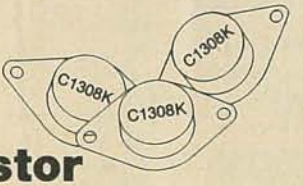

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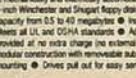

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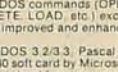

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SN7472N	.34	SN74190N	1.15
SN7473N	.38	SN74191N	1.15
SN7474N	.36	SN74192N	.85
SN7475N	.38	SN74193N	.85
SN7476N	.36	SN74194N	.85
SN7479N	4.60	SN74195N	.85
SN7480N	.59	SN74196N	.85
SN7481N	1.10	SN74197N	.85
SN7482N	1.10	SN74198N	1.39
SN7483N	.55	SN74199N	1.39
SN7485N	.65	SN74221N	1.39
SN7486N	.39	SN74251N	.95
SN7489N	1.75	SN74273N	1.05
SN7490N	.39	SN74279N	.89
SN7491N	.65	SN74283N	2.15
SN7492N	.52	SN74284N	3.90
SN7493N	.49	SN74285N	3.90
SN7494N	.72	SN74290N	1.25
SN7495N	.65	SN74298N	.95
SN7496N	.72	SN74365N	.68
SN7497N	3.10	SN74366N	.68
SN74100N	.99	SN74367N	.79
SN74107N	.32	SN74368N	.79
SN74109N	.53	SN74390N	1.90
SN74116N	1.95	SN74393N	1.90
SN74121N	.29	SN74490N	1.90
SN74122N	.39		

74LS00

74LS00N	.35	74LS164N	1.19
74LS01N	.28	74LS165N	.89
74LS02N	.28	74LS166N	2.48
74LS03N	.28	74LS168N	1.89
74LS04N	.39	74LS169N	1.89
74LS05N	.28	74LS170N	1.99
74LS08N	.39	74LS173N	.89
74LS09N	.39	74LS174N	.99
74LS10N	.28	74LS175N	.99
74LS11N	.39	74LS181N	2.20
74LS12N	.39	74LS190N	1.15
74LS13N	.47	74LS191N	1.15
74LS14N	1.25	74LS192N	.98
74LS15N	.39	74LS193N	.98
74LS20N	.26	74LS194N	1.15
74LS21N	.38	74LS195N	.95
74LS22N	.38	74LS196N	.89
74LS26N	.39	74LS197N	.89
74LS27N	.39	74LS221N	1.49
74LS28N	.39	74LS240N	1.95
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74LS32N	.39	74LS242N	1.95
74LS37N	.79	74LS243N	1.95
74LS38N	.39	74LS244N	1.95
74LS40N	.26	74LS245N	4.95
74LS42N	.79	74LS247N	1.10
74LS47N	.79	74LS248N	1.10
74LS48N	.79	74LS249N	1.69
74LS51N	.26	74LS251N	1.79
74LS54N	.35	74LS253N	.98
74LS55N	.35	74LS257N	.98
74LS73N	.45	74LS258N	.98
74LS74N	.59	74LS259N	2.95
74LS75N	.68	74LS260N	.69
74LS76N	.45	74LS261N	2.49
74LS78N	.65	74LS266N	.59
74LS83AN	.99	74LS273N	1.75
74LS85N	1.19	74LS275N	4.40
74LS86N	.45	74LS279N	.59
74LS90N	.75	74LS283N	1.10
74LS92N	.75	74LS290N	1.29
74LS93N	.75	74LS293N	1.95
74LS95N	.88	74LS295N	1.10
74LS96N	.98	74LS298N	1.29
74LS107N	.45	74LS324N	1.75
74LS109N	.45	74LS347N	1.95
74LS112N	.49	74LS348N	1.95
74LS113N	.49	74LS352N	1.65
74LS114N	.55	74LS353N	1.65
74LS122N	.55	74LS363N	1.49
74LS123N	1.19	74LS365N	.99
74LS124N	1.35	74LS366N	.99
74LS125N	.89	74LS367N	.73
74LS126N	.89	74LS368N	.73
74LS132N	.79	74LS373N	2.75
74LS136N	.59	74LS374N	2.75
74LS138N	.89	74LS375N	.69
74LS139N	.89	74LS377N	1.95
74LS145N	1.25	74LS385N	1.95
74LS148N	1.49	74LS386N	.65
74LS151N	.79	74LS390N	1.95
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74LS154N	2.49	74LS395N	1.70
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CD4071	.35	74C164	2.39
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74LS37	.55	74LS242	1.85
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74LS42	.55	74LS245	2.85
74LS47	.75	74LS247	.76
74LS48	.75	74LS248	1.25
74LS49	.75	74LS249	.99
74LS51	.25	74LS251	1.30
74LS54	.35	74LS253	.85
74LS55	.35	74LS257	.85
74LS63	1.25	74LS258	.85
74LS73	.40	74LS259	2.85
74LS74	.45	74LS260	.65
74LS75	.50	74LS266	.55
74LS76	.40	74LS273	1.65
74LS78	.50	74LS275	3.35
74LS83	.75	74LS279	.55
74LS85	1.15	74LS280	1.98
74LS86	.40	74LS283	1.00
74LS90	.65	74LS290	1.25
74LS91	.89	74LS293	1.85
74LS92	.70	74LS295	1.05
74LS93	.65	74LS298	1.20
74LS95	.85	74LS352	1.55
74LS96	.95	74LS353	1.55
74LS107	.40	74LS363	1.35
74LS109	.40	74LS365	.95
74LS112	.45	74LS366	.95
74LS113	.45	74LS367	.70
74LS114	.50	74LS368	.70
74LS122	.45	74LS373	1.85
74LS123	.95	74LS374	1.80
74LS124	2.99	74LS377	1.45
74LS125	.95	74LS378	1.18
74LS126	.85	74LS379	1.35
74LS132	.75	74LS385	1.90
74LS136	.55	74LS386	.65
74LS137	.99	74LS390	1.90
74LS138	.75	74LS393	1.90
74LS139	.75	74LS395	1.65
74LS145	1.20	74LS399	1.70
74LS147	2.49	74LS447	.37
74LS148	1.35	74LS490	1.95
74LS151	.75	74LS668	1.69
74LS153	.75	74LS669	1.89
74LS154	2.35	74LS670	2.20
74LS155	1.15	74LS674	9.65
74LS156	.95	74LS682	3.20
74LS157	.75	74LS683	2.30
74LS158	.75	74LS684	2.40
74LS160	.90	74LS685	2.40
74LS161	.95	74LS688	2.40
74LS162	.95	74LS689	2.40

7400 SERIES

7400	.19	74128	.55
7401	.19	74132	.45
7402	.19	74136	.50
7403	.19	74141	.65
7404	.19	74142	2.95
7405	.22	74143	2.95
7406	.22	74144	2.95
7407	.22	74145	.60
7408	.24	74147	1.75
7409	.19	74148	1.20
7410	.19	74150	1.35
7411	.25	74151	.65
7412	.30	74152	.65
7413	.35	74153	.55
7414	.55	74154	1.40
7416	.25	74155	.75
7417	.25	74156	.65
7420	.19	74157	.55
7421	.35	74159	1.65
7422	.29	74160	.85
7423	.29	74161	.70
7425	.29	74162	.85
7426	.29	74163	.85
7427	.29	74164	.85
7428	.45	74165	.85
7430	.19	74166	1.00
7432	.29	74167	1.95
7433	.45	74170	1.65
7437	.29	74172	5.95
7438	.29	74173	.75
7440	.19	74174	.89
7442	.49	74175	.89
7443	.65	74176	.89
7444	.69	74177	.75
7445	.69	74178	1.15
7446	.59	74179	1.75
7447	.69	74180	.75
7448	.69	74181	2.25
7450	.19	74182	.75
7451	.23	74184	2.00
7453	.23	74185	2.00
7454	.23	74186	18.50
7460	.23	74190	1.15
7464	.39	74191	1.15
7465	.39	74192	.79
7470	.35	74193	.79
7472	.29	74194	.85
7473	.34	74195	.85
7474	.35	74196	.79
7475	.49	74197	.75
7476	.35	74198	1.35
7480	.59	74199	1.35
7481	1.10	74221	1.35
7482	.95	74246	1.35
7483	.50	74247	1.25
7484	.50	74248	1.85
7485	.65	74249	1.95
7486	.35	74251	.75
7489	4.95	74259	2.25
7490	.35	74265	1.35
7491	.40	74273	1.95
7492	.50	74276	1.25
7493	.49	74279	.75
7494	.65	74283	2.00
7495	.55	74284	3.75
7496	.70	74285	3.75
7497	2.75	74290	.95
74100	1.00	74293	.75
74107	.30	74298	.85
74109	.45	74351	2.25
74110	.45	74365	.65
74111	.55	74366	.65
74116	1.55	74367	.65
74120	1.20	74368	.65
74121	.29	74376	2.20
74122	.45	74390	1.75
74123	.55	74393	1.35
74125	.45	74425	3.15
74126	.45	74426	.85
		74490	2.55

T.V. CIRCUITS

MC1330	1.89
MC1350	1.29
MC1358	1.79
LM380	1.29
LM386	1.50
LM565	.99
LM741	.29
LM1310	2.90
LM1800	2.99
LM1889	2.49

MISC.

8T26	1.69	3242	9.95
8T28	2.49	AY5-1013	3.95
8T95	.99	TR1602	4.95
8T96	.99	IM6402	7.95
8T97	.99	1771	24.95
8T98	.99	1791	36.95
1488	.99	UPD765	39.95
1489	.99	8272	39.95
DM8131	2.95		

CMOS

74C00	.35	74C373	2.75	4018	.95	4093	.95
74C02	.35	74C374	2.75	4019	.45	4099	1.95
74C04	.35	74C901	.80	4020	.95	14409	8.95
74C08	.35	74C902	.85	4021	.95	14410	8.95
74C10	.35	74C903	.85	4022	1.15	14411	9.95
74C14	1.50	74C905	10.95	4023	.35	14412	12.95
74C20	.35	74C906	.95	4024	.75	14419	2.95
74C30	.35	74C907	1.00	4025	.35	4502	.95
74C32	.50	74C908	2.00	4026	1.65	4503	.65
74C42	1.75	74C909	2.75	4027	.65	4508	1.95
74C48	2.10	74C910	9.95	4028	.80	4510	.95
74C73	.65	74C911	10.00	4029	.95	4511	.95
74C74	.85	74C912	10.00	4030	.45	4512	.95
74C76	.80	74C914	1.95	4034	2.95	4514	1.25
74C83	1.95	74C915	2.00	4035	.85	4515	2.25
74C85	1.95	74C918	2.75	4040	.95	4516	1.55
74C86	.95	74C920	17.95	4041	1.25	4518	1.25
74C89	4.50	74C921	15.95	4042	.75	4519	1.25
74C90	1.75	74C922	5.95	4043	.85	4520	1.25
74C93	1.75	74C923	5.95	4044	.85	4522	1.25
74C95	1.75	74C925	6.75	4046	.95	4526	1.25
74C107	1.00	74C926	7.95	4047	.95	4527	1.95
74C150	5.75	74C927	7.95	4049	.55	4528	1.25
74C151	2.25	74C928	7.95	4050	.55	4531	.95
74C154	3.25	74C929	19.95	4051	.95	4532	1.95
74C157	1.75	74C930	19.95	4053	.95	4538	1.95
74C160	2.00	4000	.35	4060	1.45	4539	1.95
74C161	2.00	4001	.35	4066	.75	4543	2.70
74C162	2.00	4002	.25	4068	.40	4555	.95
74C163	2.00	4006	.95	4069	.35	4556	.95
74C164	2.00	4007	.29	4070	.35	4581	1.95
74C165	2.00	4008	.95	4071	.30	4582	1.95
74C173	2.00	4009	.45	4072	.30	4584	.95
74C174	2.25	4010	.45	4073	.30	4585	.95
74C175	2.25	4011	.35	4075	.30	4702	12.95
74C192	2.25	4012	.25	4076	.95	4724	1.50
74C193	2.25	4013	.45	4078	.30	80C07	.95
74C195	2.25	4014	.95	4081	.30	80C95	.85
74C200	5.75	4015	.95	4082	.30	80C96	.95
74C221	2.25	4016	.45	4085	.95	80C97	.95
		4017	1.15	4086	.95	80C98	1.20

DIP SWITCHES

4 position	.85
5 position	.90
6 position	.90
7 position	.95
8 position	.95

CONNECTORS

RS232 MALE	3.25
RS232 FEMALE	3.75
RS232 HOOD	1.25
S-100 ST	3.95
S-100 WW	4.95

TRANSISTORS

PN2222	10/1.00	100/8.99
2N3904	10/1.00	100/8.99
2N3906	10/1.00	100/8.99
2N3055	.79	10/6.99
IN4148		25/1.00
IN4004		10/1.00

74S00 SERIES

74S00	.44	74S74	.69	74S163	3.75	74S258	1.49
74S02	.48	74S85	2.39	74S168	4.65	74S260	1.83
74S03	.48	74S86	1.44	74S169	5.44	74S274	19.95
74S04	.79	74S112	1.59	74S174	1.09	74S275	19.95
74S05	.79	74S113	1.98	74S175	1.09	74S280	2.90
74S08	.48	74S114	1.50	74S181	4.47	74S287	4.75
74S09	.98	74S124	2.77	74S182	2.95	74S288	4.45
74S10	.69	74S132	1.24	74S188	3.95	74S289	6.98
74S11	.88	74S133	.98	74S189	14.95	74S301	6.95
74S15	.70	74S134	.69	74S194	2.95	74S373	3.45
74S20	.68	74S135	1.48	74S195	1.89	74S374	3.45
74S22	.98	74S138	1.06	74S196	4.90	74S381	7.95
74S30	.48	74S139	1.25	74S197	4.25	74S387	5.75
74S32	.98	74S140	1.45	74S201	14.95	74S412	2.98
74S37	1.87	74S151	1.19	74S225	8.95	74S471	9.95
74S38	1.68	74S153	1.19	74S240	3.98	74S472	16.85
74S40	.44	74S157	1.19	74S241	3.75	74S474	17.85
74S51	.78	74S158	1.45	74S251	1.90	74S482	15.60
74S64	.79	74S161	2.85	74S253	7.45	74S570	7.80
74S65	1.25	74S162	3.70	74S257	1.39	74S571	7.80

VOLTAGE REG'S

7805T	.89	7905T	.99
7808T	.99	7912T	.99
7812T	.89	7915T	1.19
7815T	.99	7924T	1.19
7824T	.99		
7805K	1.39	7905K	1.49
7812K	1.39	7912K	1.49
7815K	1.39		
78L05	.69	79L05	.79
78L12	.69	79L12	.79
78L15	.69	79L15	.79
LM309K	1.49	LM323K	4.95
LM317T	1.95	LM337K	3.95
LM317K	3.95		

T = TO-220 K = TO-3 L = TO-92

LINEAR

LM301V	.34	LM741V	.29
LM308V	.98	LM747	.79
LM309K	1.49	LM748V	.59
LM311	.64	LM1310	2.90
LM317T	1.95	MC1330	1.89
LM317K	3.95	MC1350	1.29
LM318	1.49	MC1358	1.79
LM323K	4.95	LM1414	1.59
LM324	.59	LM1458V	.69
LM337K	3.95	LM1488	1.39
LM339	.99	LM1489	1.39
LM377	2.29	LM1800	2.99
LM380	1.29	LM1889	2.49
LM386V	1.50	LM3900	.59
LM555V	.39	LM3909V	.98
LM556	.69	LM3914	3.95
LM565	.99	LM3915	3.95
LM566V	1.49	LM3916	3.95
LM567V	1.29	75451V	.39
LM723	.49	75452V	.39
LM733	.98	75453V	.39

T=TO-220 V=8 PIN K=TO-3

master charge VISA

JDR MICRODEVICES, INC.
1101 South Winchester Blvd.
San Jose, California 95128
800-538-5000 800-662-6263 (Calif.)
408-247-4852

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CIRCLE 63 ON FREE INFORMATION CARD

4K STATIC RAMS 8/18.95

2114 LOW POWER 450ns

ALL MERCHANDISE 100% GUARANTEED **CALL US FOR VOLUME QUOTES**

8200

8202	45.00
8205	3.50
8212	1.95
8214	3.90
8216	1.85
8224	2.50
8226	1.85
8228	4.95
8237	19.95
8238	4.95
8243	4.50
8250	14.95
8251	5.50
8253	9.85
8253-5	9.85
8255	5.25
8255-5	5.25
8257	9.00
8259	7.00
8272	39.95
8275	29.95
8279	10.50
8279-5	10.50
8282	6.65
8283	6.65
8284	5.80
8286	6.65
8287	6.65
8288	25.00
8289	49.95

6800

6800	6.95
6802	11.95
6809	37.95
6810	4.60
6820	4.95
6821	4.95
6828	9.95
6834	16.95
6840	14.95
6843	42.95
6844	44.95
6845	29.95
6847	15.95
6850	4.75
6852	5.75
6860	10.95
6862	11.95
6871	25.95
6875	6.95
6880	2.95

Z80

Z80	8.95
Z80A	9.95
Z80B	19.95
Z80-PIO	6.50
Z80A-PIO	8.60
Z80-CTC	6.50
Z80A-CTC	8.65
Z80-DART	15.25
Z80A-DART	18.75
Z80-DMA	17.50
Z80A-DMA	27.50
Z80-SIO/0	23.95
Z80A-SIO/0	28.95
Z80-SIO/1	23.95
Z80A-SIO/1	28.95
Z80-SIO/2	23.95
Z80A-SIO/2	28.95
Z80-SIO/9	17.95
Z80A-SIO/9	22.95

6502

6502	6.95
6502A	12.95
6504	6.95
6505	8.95
6520	4.95
6522	9.95
6532	14.95
6551	14.95

MPU'S

8035	16.95
8039	19.95
8080A	3.95
8085	12.95
8086	99.95
8088	39.95
8155	11.95
8156	11.95
8185	29.95
8185-2	39.95
8741	39.95
8748	69.95
8755	49.95

IC SOCKETS

	1-100	100pcs
8 pin ST	.13	.11
14 pin ST	.15	.12
16 pin ST	.17	.13
18 pin ST	.20	.18
20 pin ST	.29	.27
22 pin ST	.30	.27
24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39
ST = SOLDERTAIL		
8 pin WW	.59	.49
14 pin WW	.69	.52
16 pin WW	.69	.58
18 pin WW	.99	.90
20 pin WW	1.09	.98
22 pin WW	1.39	1.28
24 pin WW	1.49	1.35
28 pin WW	1.69	1.49
40 pin WW	1.99	1.80
WW = WIREWRAP		

BEFORE YOU BUY CALL JDR FOR THE BEST PRICE.

800-538-5000

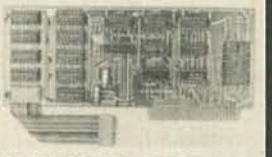
800-662-6233

(CALIFORNIA RESIDENTS)

APPLE OWNERS

EXPAND YOUR 48K COMPUTER TO 64K

SUPER RAM•II

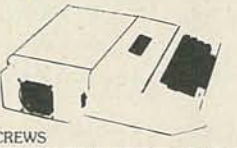


- PLUG IN SLOT ϕ
- GOLD PLATED CONTACTS
- INCLUDES 5 JUMPER OPTIONS
- INCLUDES 5 RAM-ROM OPTIONS
- ENJOY THE BEST OF BOTH WORLDS
- 16K RAM (RANDOM ACCESS MEMORY)
- THIS IS SOPHISTICATED FIRMWARE
- EXPANDS YOUR 48K APPLE TO 64K OF PROGRAMMABLE MEMORY
- ELIMINATES THE NEED FOR APPLESOFT* OR INTEGER BASIC ROM CARD
- ALLOWS YOU TO RUN APPLE'S NEW FORTRAN PACKAGE ALSO PASCAL AND PILOT
- KEYBOARD CONTROL SELECTION OF RAM OR MOTHER BOARD ROM LANGUAGE
- INCLUDES: INSTALLATION INSTRUCTIONS AND APPLICATIONS NOTES
- THE SOFTWARE DEVELOPED BY VARIOUS VENDORS FOR YOUR (64K) SHOULD NOW WORK AS THEY ADVERTISED
- THE MOST VERSATILE RAM EXPANSION ON THE MARKET TODAY

UNIQUE 1 YEAR WARRANTEE!! $168.00

SUPER FAN II

"COOL-IT"



- TAN COLOR
- SAVE DOWN TIME
- LONG LIFE MOTOR
- LOW NOISE IS A MUST
- SAVE REPAIR CHARGES
- INCREASES RELIABILITY
- CLIPS ON—NO HOLES OR SCREWS
- MINIMUM QUIETNESS IS DUE TO THE DRAW EFFECT OF AIR THROUGH YOUR COMPUTER AND A SPECIAL FAN AND MOTOR DESIGN
- THOSE EXTRA PLUG-IN CARDS CAN CAUSE EXTRA HEAT

HOW TO HOOK IT UP

1. Clip it on your APPLE
2. Unplug your 120V cable (you won't need it)
3. Plug short 120V cable from Super Fan II to the back of your computer
4. Plug the supply cable from Super Fan II to your 120V power source
5. Turn on the rocker switch and a built-in red ready light comes on
6. You are all set *"COOL IT"*

UNIQUE 1 YEAR WARRANTEE!! $69.00

*APPLE IS A TRADEMARK OF APPLE COMPUTER INC.

LEDS

Jumbo Red	10/1.00
Jumbo Green	6/1.00
Jumbo Yellow	6/1.00
5082-7760 .43"CC	.79
MAN74 .3"CC	.99
MAN72 .3"CA	.99

DYNAMIC RAMS

			100pcs
4027	(250ns)	2.50	2.00
4116-150	(150ns)	8/21.95	2.65
4116-200	(200ns)	8/19.95	2.35
4116-300	(300ns)	8/16.95	2.00
4164	(200ns)	CALL	CALL

EPROMS

				8pcs
1702		256 × 8	(1us)	4.95	4.50
2708		1024 × 8	(450ns)	3.95	3.50
2716	(5v)	2048 × 8	(450ns)	6.95	5.95
2758	(5v)	1024 × 8	(450ns)	9.95	8.95
2716-1	(5v)	2048 × 8	(350ns)	12.95	11.95
TMS2716		2048 × 8	(450ns)	9.95	8.95
TMS2532	(5v)	4096 × 8	(450ns)	21.95	19.95
2732	(5v)	4096 × 8	(450ns)	17.95	16.95

STATIC RAMS

				100pcs
2101		(450ns)	1.95	1.85
2102-1		(450ns)	.89	.85
21L02-1	(LP)	(450ns)	1.29	1.15
2111		(450ns)	2.99	2.49
2112		(450ns)	2.99	2.79
2114		(450ns)	8/18.95	2.25
2114L-2	(LP)	(200ns)	8/22.95	2.45
2114L-3		(300ns)	8/21.95	2.45
2113L-4	(LP)	(450ns)	8/18.95	2.25
4044-4		(450ns)	3.49	3.25
4044-3		(300ns)	3.99	3.75
TMM2016		(200ns)	CALL	CALL
MB6116		(200ns)	CALL	CALL

LP = LOW POWER

PROMS

74S188	(82S23)	OC	32 × 8	3.95
74S287	(82S129)	TS	256 × 4	4.75
74S288	(82S123)	TS	32 × 8	4.45
74S387	(82S126)	OC	256 × 4	5.75
74S471		TS	256 × 8	9.95
74S472	(82S147)	TS	512 × 8	16.85
74S474	(82S141)	TS	512 × 8	17.85
74S570	(82S130)	OC	512 × 4	7.80
74S571	(82S131)	TS	512 × 4	7.80

master charge VISA®

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CIRCLE 63 ON FREE INFORMATION CARD

MOVING SALE MOVING SALE

DETACH OUR CATALOG FROM THE MAY BYTE

MODEM SALE $129.00

THE STAR MODEM from LIVERMORE

FEATURE
FITS GTE HANDSETS!

2 YEAR WARRANTY

EXCLUSIVE ACOUSTIC CHAMBERS

The exclusive triple seal of Livermore's new flat mounted cups locks the handset into the acoustic chamber yielding superior acoustic isolation and mechanical cushioning. Designed to adapt to most common handsets used throughout the world, the STAR offers the utmost in flexibility and transmission reliability.

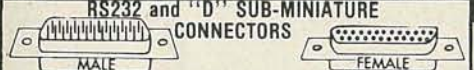
Specifications:
- **Data Rate:** 0 to 300 baud
- **Compatibility:** Bell 103 and 113; CCITT
- **Frequency Stability:** ±0.3 percent. Crystal controlled
- **Receiver Sensitivity:** —50 dBm ON, —53 dBm OFF
- **Modulation:** Frequency shift keyed (FSK)
- **Carrier Detect Delay:** 1.2 seconds ON; 120 msec OFF
- **EIA Terminal Interface:** Compatible with RS 232 specifications
- **Teletype Interface:** 20 milliampere current loop
- **Optional Interfaces:** IEEE 488; TTL; TTY 43
- **International (CCITT) frequencies available**
- **Switches:** Originate/Off/Answer; Full Duplex/Test/Half Duplex
- **Indicators:** Transmit Data, Receive Data, Carrier Ready, Test
- **Power:** Supplied by 24 VAC/150 MA UL/CSA listed wall-mount transformer. Input 115 VAC, 2.5 watts. (A 220 VAC, 50 Hz adaptor is available upon request.)
- **Dimensions:** 10" x 4" x 2"
- **Weight:** 1.74 lbs. (3 lbs. shipping weight including AC adaptor.)
- **Warranty:** Two years on parts and labor, excluding the AC adaptor which carries the manufacturer's warranty

Part No.	Description	List Price	SALE PRICE
LIV-STAR	RS232, TTL, 20 MA Current Loop	$199.00	$129.00

CABLES

Part No.	Description	Price
CND-RS2328F	RS232 8 Cond 8 ft	$19.95

RS232 and "D" SUB-MINIATURE CONNECTORS



P = Plug, Male Type - S = Socket, Female Type - C = Cover, Hood

PART NO.	DESCRIPTION	PRICE 1-9	10-24	25-99
CND-DE9P	9 PIN MALE	$ 2.10	$ 1.90	$ 1.70
CND-DE9S	9 PIN FEMALE	$ 2.70	$ 2.40	$ 2.10
CND-DE9C	9 PIN COVER	$ 1.50	$ 1.25	$ 1.10
CND-DA15P	15 PIN MALE	$ 2.75	$ 2.45	$ 2.15
CND-DA15S	15 PIN FEMALE	$ 3.95	$ 3.60	$ 3.20
CND-DA15C	15 PIN COVER	$ 1.50	$ 1.30	$ 1.10
CND-DB25P	25 PIN MALE	$ 3.00	$ 2.75	$ 2.60
CND-DB25S	25 PIN FEMALE	$ 4.00	$ 3.75	$ 3.50
CND-DB51212	1 PC. GREY HOOD	$ 1.60	$ 1.45	$ 1.30
CND-P25H	2 PC. GREY HOOD	$ 1.50	$ 1.25	$ 1.10
CND-DB51226	2 PC. BLACK HOOD	$ 1.90	$ 1.65	$ 1.45
CND-DC37P	37 PIN MALE	$ 5.80	$ 5.10	$ 4.45
CND-DC37S	37 PIN FEMALE	$ 8.70	$ 7.70	$ 6.70
CND-DC37C	37 PIN COVER	$ 1.80	$ 1.55	$ 1.30
CND-DD50P	50 PIN MALE	$ 8.75	$ 7.75	$ 6.70
CND-DD50S	50 PIN FEMALE	$11.65	$10.25	$ 8.90
CND-DD50C	50 PIN COVER	$ 2.00	$ 1.80	$ 1.60
CND-D20418	HARDWARE SET 2 PR	$ 1.00	$ 0.80	$ 0.70
CND-RS2328F	RS232, DB25P, EIA CLASS1CABLE8CON 8 FT.	$19.95	$17.95	$15.95
CND-5730360	CENT. 700 SERIES PRINTER CONNECTOR	$ 9.00	$ 7.50	$ 6.00

GOLD S-100 CONNECTORS

SOLDER TAIL PRICE

Part No.	1-9	10-24	25-99	100-249
S100 STG	3.20	2.90	2.50	2.20

WIRE WRAP PRICE

Part No.	1-9	10-24	25-99	100-249
S100 WWG	4.00	3.75	3.50	3.25

2016P3
2Kx8 L/P STATIC RAM
8/$100.00

2708 450ns 8K EPROM — $8.50 EA. 8/$32.00

2716 450ns 5 Volt only 16 K EPROM — $11.95 EA 8/$48.00

2114-3L
4096 BIT (1024x4) 300ns LOW POWER STATIC RAM
8/$30.00
100 + $3.00

5257-3L
(TMS 4044)
4096x1 300ns LOW POWER STATIC RAM
8/$50.00
100 pcs. + $4.75

TRS-80/APPLE MEMORY EXPANSION KITS
4116's RAMS
from Leading Manufacturers
(16Kx1 200ns)
100% GUARANTEED 1,000's SETS SOLD
8 for $24.00
ADD $3.00 FOR PROGRAMMING JUMPERS FOR TRS-80 KEYBOARD
4116's 100 pcs & UP $2.75 each
1000 pcs & UP $2.50 each

PROTECT YOUR INVESTMENT
PROTECT YOUR DATA WITH

ISOBAR™

GOF-IBAR46
- Inductively isolated grounds
- Sockets individually filter isolated
- Each socket isolated from power line

LIST PRICE $79.95
SALE PRICE $39.95

6 OUTLET MULTI USE CORD REEL

SH. WT. 5 LBS.

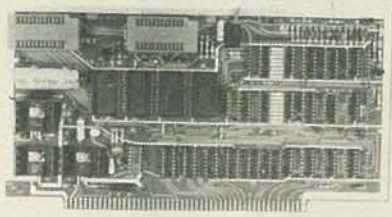
THE CONVENIENCE OF AN EXTENSION CORD AND POWER DISTRIBUTION PANEL IN ONE COMPACT, SELF-STORING UNIT!

- SIX GROUNDED 3-PRONG OUTLETS!
- 7 M (22 FT. or 50 FT.) 14 GAUGE, 3-CONDUCTOR POWER CORD - RATED FOR INDOOR/OUTDDOR USE!
- CIRCUIT BREAKER FOR SAFETY'S SAKE — GUARDS AGAINST OVERLOADS ABOVE 10 AMPS

INDESTRUCTIBLE SPACE-AGE PLASTIC CASE DESIGNED FOR YEARS OF HEAVY USE!

GOF-CR21 22 Ft. - 5 lbs. **$24.95**
GOF-CR50 50 ft. - 10 lbs. **$39.95**

SSM



PB1 2708/2716 PROGRAMMER & 4K/8K EPROM BOARD

PB1 has two separate programming circuits so 2708 or 2716 (5v) type of EPROMs can be programmed without modifying the board. Programming voltage is generated on-board; no need for an external power supply. Programming sockets are Dip Switch addressable to any 4K boundary. And complete software is provided for programming and verifying EPROMs.

Unused EPROM sockets don't take memory space, so you are never committed to the full 4K or 8K of memory.

		List Price	Our Price
SSMPB1K	Kit		$179.00
SSMPB1A	Assembled & Tested	$265.00	$230.00

5¼" DISKETTES

Part No.	Sectoring	Application	# of heads	Box/10
VRB-MD525-01	Soft Sector	TRS-80 Apple 40 Track Cert	1	$32.00
VRB-MD525-10	Hard 10 Sector	North Star 40 Track Cert.	1	$32.00
VRB-MD525-16	Hard 16 Sector	Micropolis 40 Track Cert.	1	$32.00
VRB-MD557-01	Soft Sector	77 Track Cert 100TPI	2	$56.00
VRB-MD557-10	Hard 10 Sector	77 Track Cert 100 TPI	2	$56.00
VRB-MD557-16	Hard 16 Sector	77 Track Cert 100 TPI	2	$56.00
VRB-MD577-01	Soft Sector	77 Track Cert 100 TPI	1	$48.00
VRB-MD577-10	Hard 10 Sector	77 Track Cert 100 TPI	1	$48.00
VRB-MD577-16	Hard 16 Sector	77 Track Cert. 100 TPI	1	$48.00

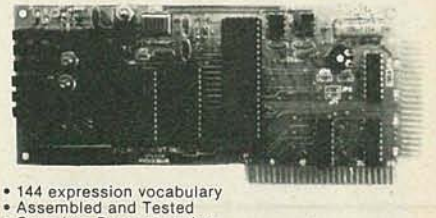
VRBMD Series comes with reinforced hub ring mounted.

8" DISKETTES

VRB-FD32	Hard Sector	Shugart 801R	1	$37.00
VRB-FD34	Soft Sector	IBM 3740	1	$37.00
VRB-FD32-2	Hard Sector	Flippy	1	$66.00
VRB-FD34-2	Soft Sector	Flippy	1	$66.00

Verbatim 8" Diskettes have all the Datalife improvements without the hardhole reinforcement rings.
ALL VERBATIM DISKETTES ARE DOUBLE DENSITY CERTIFIED

Ciarcia's Circuit Cellar MICROMOUTH
SPEECH PROCESSOR
AS FEATURED IN JUNE BYTE, PAGE 46



- 144 expression vocabulary
- Assembled and Tested
- Complete Documentation
- Connect to a speaker or Power Amplifer
- Plugs into Apple II
- Plug compatable with TRS-80 Model 1
- May be adapted to run on the S-100, H-8, or any parallel part.

		OUR PRICE
MMI-94V0APL	For use with APPLE II, or modified to run with other parallel parts	$149.00
MMI-94V0TRSI	TRS-80 Model I compatable, complete with interface cable and AC Adapter, less enclosure	$169.00

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9161-R DEERING AVE. • CHATSWORTH, CA 91311

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SCOPE SALE

OUR LOWEST PRICES OF THE YEAR!

HITACHI
Hitachi Denshi, Ltd.

Single and dual trace, 15 thru 100 MHz. All high sensitivity Hitachi oscilloscopes are built to demanding Hitachi quality standards and are backed by a 2-year warranty. They're able to measure signals as low as 1mV/division (with X5 vertical magnifier). It's a specification you won't find on any other 15 or 30 MHz scopes. Plus: Z-axis modulation, trace rotation, front panel X-Y operation for all scope models, and X10 sweep magnification. And, 30 thru 100 MHz oscilloscopes offer internal signal delay lines. For ease of operation, functionally-related controls are grouped into three blocks on the color coded front panel. Now here's the clincher: For what you'd expect to pay more, you actually pay less. Check our scopes before you decide. All scopes complete with probes.

Hitachi...The measure of quality.

HITV302B

30MHZ DUAL TRACE OSCILLOSCOPE

List $995.00
SALE $819.00

- TV sync-separater circuit
- High-sensivity 1mV/div (5MHz)
- Sweep-time magnifier (10 times)
- Z-axis input (intensity modulation)
- Signal delay line
- Complete with 2 probes
- CH1, CH2, DUAL, ADD, DIFF, Vertical Deflection Modes
- X-Y operation
- Trace Rotation

HITV152B DUAL TRACE 15MHZ (no delay)

LIST $735.00 **SALE $629.00**

HIT-V202
20MHz DUAL TRACE

LIST PRICE: $850
SALE PRICE: $775.00

- Dynamic range 8 div.
- TV sync-separator circuit
- Built-in signal delay line (V-352)
- X-Y operation
- Sweep-time magnifier (10 times)
- Trace rotation system
- Fine-adjusting, click-positioning function

HIT-V352
35MHz DUAL TRACE WITH DELAY

LIST PRICE: $1150.00
SALE PRICE $950.00

- Economically priced dual trace oscilloscope
- Square CRT with internal graticule (illuminated scale)
- High-accuracy voltage axis & time axis set at ± 3% (certified at 10° to 35°C)
- High-sensitivity 1mV/div.
- Low drift
- 2 Year Warranty

50MHz & 100 MHz DUAL TRACE WITH CALIBRATED TIME DELAY

HIT V550B
50MHz with 3rd TRACE TRIGGER VIEW
LIST $1745.00
SALE
CALL

HIT V1050
100MHz with 3rd & 4th TRACE TRIGGER VIEW
LIST $2390.00
SALE
CALL

The HITACHI V550B (50mHz) and V1050 (100mHz) offer all the capabilities you might expect from a lab grade oscilloscope. Capabilities such as 3rd trace trigger view, a bright 6" square CRT, and a max. sweep rate of 2ns/div (V1050) 5ns/div (V550B). Also, features you may not expect like, sensitivity of 1mv/div (V550B) .5mv/div (V1050) @ 10mHz, automatic focus correction.

EPSON MX-80 PRINTERS

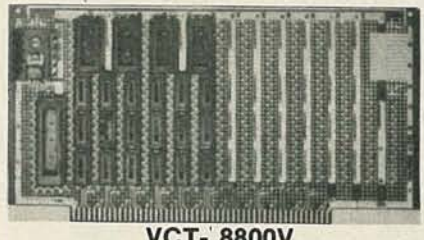
Among its features, the MX-80 prints 96 ASCII, 64 graphics and 8 international character in tack-sharp 9x9 matrix. It prints bidirectionally at 80 CPS with a logical seeking function to maximize all of these capabilities. And it has the world's first disposable print head, with a life expectancy of over 50 million characters. When it wears out, just snap it out and throw it away! A new one costs less than $30., and you can install it yourself...with one hand.

The most revolutionary thing about he Epson MX-80 isn't the bidirectional printing or the logical seeking function. It isn't even the disposable print head -although that's pretty revolutionary. The most revolutionary thing about the MX-80 is the price.

EPN-MX80	MX80 Tractor Feed List $649.00 **Sale Price**	**$475.00**
EPN-MX80V2	MX80 with Graphics option	**$525.00**
EPN-MX80TF	MX80 with both tractor and friction feed	**$575.00**
EPN-MX82	MX80 with high density graphics option	**$575.00**

Vector

S-100 COMPATIBLE PLUGBOARDS FOR INTERFACE, MEMORY EXPANSION, EXPERIMENTATION



VCT- 8800V
Universal Microcomputer/processor plugboard, use with S-100 bus. Complete with heat sink & Hardware. 5.3" x 10" x 1/16."

1 - 4	5 - 9	10 - 24
$22.48	$20.37	$18.26

VCT- 8801-1
Plain no etched circuitry except contacts. Produces maximum flexibility.

1 - 4	5 - 9	10 - 24
$15.67	$14.24	$12.82

CompuPro™ from GODBOUT ELECTRONICS

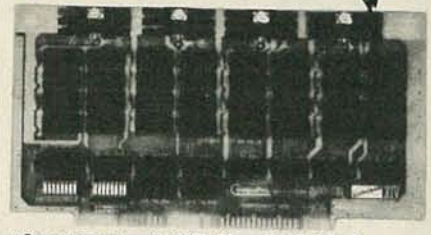
ANOTHER FAMOUS PRIORITY 1 ELECTRONICS TRUCK LOAD PURCHASE

10 MHZ 16K A&T STATIC S-100 RAM

GBT-143A
List $349.00

SAVE $150.00

$199.00



- Operates up to 10 MHZ (90 ns RAM Chips)
- Assembled & Tested
- Meets or exceeds all IEEE 696/S-100 specifications (including timing).
- Fully static design eliminates the timing problems associated with dynamic memories.
- Switch selectable choice of 24 address lines conforming to the IEEE 696/S-100 extended addressing specifications, or 16 address lines as used in older S-100 systems.
- Ideal for multi-user installations.
- Board is addressable as one 16K x 8 block on any 4K boundary.
- Switch selectable PHANTOM disable and write protect.
- +5 Volt operation (requires no other supply voltages).
- Low power operation (900 mA typical, 1200 mA maximum).
- 1 year Factory Warranty.

California Computer Systems LIST $425.00

CCS2422A
FLOPPY DISK CONTROLLER WITH CP/M VERSION 2.2
SALE $375.00

IEEE S-100 COMPATIBLE SINGLE/DOUBLE DENSITY
5¼"/8" DISK DRIVES
SINGLE//DOUBLE HEADED
ASSEMBLED & TESTED

CCS2810 Z80 CPU
2/4 MHZ CPU W/Serial I/O

		List Price	SALE PRICE
CCS2810	A&T	$310.00	$275.00

Shugart

SA801R SALE

SHU-SA801R
2 OR MORE
$425.00
$410.00 ea.

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ok PRODUCTS

JUST WRAP KIT

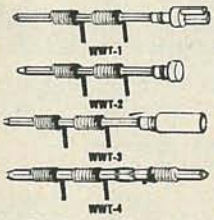
Just Wrap tool for daisy chain wiring. Tool strips as it wraps and cuts. Includes one 50 foot spool of wire.

Part No.	Description	Price
JW-1*	Just Wrap Tool	$14.95
JWK-6	Tool w/4 Spools and JUW1	24.95
R-JW*	50 Ft. Replacement Wire	3.49
JUW-1	Unwrapping Tool	3.49

*Specify Color: Red, Blue, White or Yellow.

HAND WRAP TOOL

Part No.	Description	Price
WSU30	Regular	$6.95
WSU30M	Modified	7.95



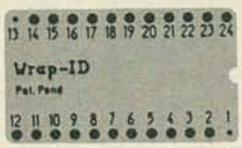
TERMINALS

- .025 (0,63mm) Square Post
- 3 Level Wire-Wrapping
- Gold Plated

25 PER PKG.

Part No.	Description	Price
WWT-1	Slotted Terminal	$4.98
WWT-2	Single Sided Terminal	2.98
WWT-3	IC Socket Term.	4.98
WWT-4	Double Sided Terminal	1.98
INS 1	Insertion Tool for above	2.49

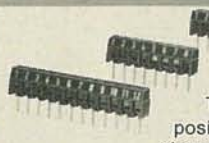
SOCKET WRAP – ID



Slipped onto socket before wrapping to identify pins.

Part #	Price	Bulk Price	Part #	Price	Bulk Price
14ID	1.49/10	5.50/100	22ID	1.49/5	5.95/50
16ID	1.49/10	5.95/100	24ID	1.49/5	5.95/50
18ID	1.49/10	5.00/50	28ID	1.49/5	6.50/50
20ID	1.49/5	5.00/50	40ID	1.49/5	5.00/25

P.C.B. TERMINAL STRIPS



The TS strips provide positive screw activated clamping action, accommodate wire sizes 14-30 AWG (1,8-0, 25mm). Pins are solder plated copper, .042 inch (1mm) diameter, on .200 inch (5mm) centers.

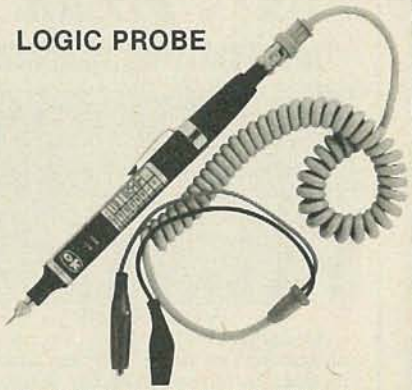
Part No.	Description	Price
TS- 4	4-Pole	$1.69
TS- 8	8-Pole	2.59
TS-12	12-Pole	3.49
TS6MD	2-Pole Interlocking	3/1.79

DESOLDERING PUMP

Easy one hand operation. Rugged all metal construction. Replaceable TEFLON® Tip. Self cleaning on each stroke. Suction precisely regulated for reliable desoldering without damage to delicate circuitry.

DSPI	Desoldering Pump	$9.95

LOGIC PROBE



Compatible with all logic families using a 4 to 15V power supply. Thresholds automatically programmed. Visual indication of logic levels to show high, low, bad level or open circuit logic pulses.

- 10 N sec. pulse responses
- 120 K input impedence.
- Automatic resetting memory.
- Includes tip with protective cap & coiled cord.

PRB-1 **$36.95**

LOGIC PULSER

Superimposes a pulse train (20 pps) or a single pulse onto the circuit node under test without un-soldering IC's.

- Automatic polarity sensing
- 2 us pulse width
- Finger tip push button actuated
- Includes tip with protective cap & coiled cord.

PSL-1 **$48.95**

VACUUM VISE

Unique vacuum-based light duty vise for precision handling of small components and assemblies. Rugged ABS construction. 1½" (32mm) travel for maximum versatility. Also features screw lugs for permanent installation.

VV1	Vacuum Vice	$3.49

HOBBY-WRAP TOOL BW263

- Auto-Indexing
- Anti-Overwrap
- Modified Wrap

Part No.	Description	Price
BW2630	Tool	$19.85
BT30	#30 Bit (not incl.)	3.95
BT2628	#28 Bit (not incl.)	7.95
BC1	Batteries & Charger	14.95

INSERTION/EXTRACTION TOOLS

Part No.	Description	Price
INS1416	14-16 pin Inserter	$3.49
MOS1416	14-16 pin MOS Safe Inserter	7.95
MOS2428	24-28 pin MOS Safe Inserter	7.95
MOS40	40 pin MOS Safe Inserter	7.95
EX1	14-16 pin IC Extractor	1.49
EX2	24-40 pin IC Extractor	7.95

WK-7 IC INSERTION K

Complete IC Inserter/ Extractor K Individual Components (listed above) $22.95

IC DISPENSER

Allows IC's to be dispensed from their tube 1 at a time and picked up by insertion tools above.

- Dispenses 8-42 pin IC's • Compatable with all IC carrying tubes • Use with WK7 for MOS safe insertion. •

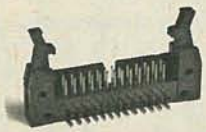
Part No.	Description	Price
MDD1	1 Chan. Dispenser	$21.85
MDD5	5 Chan. Dispenser	83.43
MDD10	10 Chan. Dispenser	160.45

• • *No Discount.

LL FREE ORDERING NUMBER 1-(800) 423-7144

DIGITAL page

IDC CONNECTORS



RIGHT ANGLE HEADERS

Size	SOLDER TAIL Part No.	Price	WIRE WRAP Part No.	Price
10	IDH10SRB	$1.20	IDH10WRB	$2.60
20	IDH20SRB	1.90	IDH20WRB	4.15
26	IDH26SRB	2.75	IDH26WRB	5.35
34	IDH34SRB	3.75	IDH34WRB	6.25
40	IDH40SRB	3.75	IDH40WRB	7.35
50	IDH50SRB	4.75	IDH50WRB	9.20

.1" Spacing. Mounts on PC Board & Mates with IDS Socket below. Ejector Bars - 4/1.00.

25 PIN "D" CONNECTORS

Solder Style	Part No.	Price
Male	DB25P	$2.95
Female	DB25S	3.95
Cover	DB25C	1.50
IDC Style		
Male	IDB25P	6.25
Female	IDB25S	6.60
Cover	IDB25C	1.60

Solder Style solders onto cable, IDC Style crimps onto cable with vise. 9, 15, 37 and 50 pin available also.

EDGE CARD CONNECTORS

Size	Part No.	Price
10	IDE10B	$3.95
20	IDE20B	4.35
26	IDE26B	5.00
34	IDE34B	6.05
40	IDE40B	6.90
50	IDE50B	7.50

.1" Spacing. Crimps onto cable with ordinary vise & mates with standard .062" Card Edge.

CABLE PLUGS

Size	Part No.	Price
14	IDP14B	$1.45
16	IDP16B	1.65
24	IDP24B	2.50
40	IDP40B	4.15

.1" Spacing. Crimps onto cable with ordinary vise & plugs into standard IC Socket.

RIBBON CABLE

Size	Solid Color 10 ft.	Solid Color 100 ft.	Color Coded 10 ft.	Color Coded 100 ft.
10	2.90	17.00	4.00	30.00
14	3.40	23.80	5.00	42.00
16	3.70	27.20	5.60	48.00
20	4.40	34.00	7.00	60.00
24	5.00	40.80	8.00	72.00
26	5.40	44.20	8.60	78.00
34	6.80	57.80	11.00	102.00
40	7.80	68.00	13.00	120.00
50	9.50	85.00	16.00	150.00

SOCKETS

Size	Part No.	Price
10	IDS10B	$1.88
20	IDS20B	2.75
26	IDS26B	3.50
34	IDS34B	4.50
40	IDS40B	5.40
50	IDS50B	6.50

.1" Spacing. Crimps onto cable with ordinary vise & mounts to header sold above.

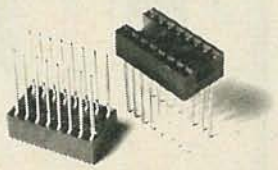
WIRE WRAP SUPPLIES

WIRE WRAP WIRE

#30 Wire Wrap Wire

Length	100/Bag	500/Bag	1K/Bag
2.5"	$1.38	$6.81	$3.94
3.0"	1.43	7.46	4.25
3.5"	1.51	8.11	4.57
4.0"	1.56	8.73	4.88
4.5"	1.63	9.39	5.21
5.0"	1.69	10.04	5.54
5.5"	1.74	10.69	5.92
6.0"	1.82	11.34	6.23
6.5"	2.11	12.99	7.08
7.0"	2.19	13.68	7.44
7.5"	2.29	14.40	7.78
8.0"	2.35	15.10	8.12
8.5"	2.40	15.80	8.46
9.0"	2.46	16.51	8.92
9.5"	2.53	17.22	9.15
10.0"	2.63	17.91	9.58

All lengths are overall, including 1" strip on each end. Choose from colors; Red, Blue, Black, Yellow, White, Green, Orange, and Violet.



Size	Part No.	Each	Tube
08	ICN083WBSG	.44	52x .39 = $20.28
14	ICN143WBSG	.53	30x .46 = $13.80
16	ICN163WBSG	.58	26x .50 = $13.00
18	ICN183WBSG	.78	23x .68 = $15.64
20	ICN203WBSG	1.00	21x .85 = $17.85
22	ICN224WBSG	1.07	19x .92 = $17.48
24	ICN246WBSG	1.09	17x1.09 = $15.98
28	ICN286WBSG	1.43	15x1.23 = $18.45
40	ICN406WBSG	1.85	10x1.60 = $16.00

Selective Plating provides gold in contact where it counts. 3-level wrap. Save by buying sockets by the tube. All gold available at ½¢/pin extra charge.

* * * No Discount

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100	4"	100	6"

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500	3"	100	5½"
500	3½"	100	6"
500	4"	100	6½"
250	4½"	100	7"

Kit No. 3 — $34.95

250	2½"	500	4½"
500	3"	500	5"
500	3½"	500	5½"
500	4"	500	6"

Kit No. 4 — $59.95

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1000	3"	1000	5"
1000	3½"	1000	5½"
1000	4"	1000	6"

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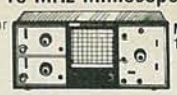

Model 1420

Dual Trace 5" 30 MHz Triggered Scope Model 1479A

Autoranging DMM Model 2845

Digital Pulsar Probe Model DP-100

50 MHz Pulsar Probe Model DP-50

BSR X-10

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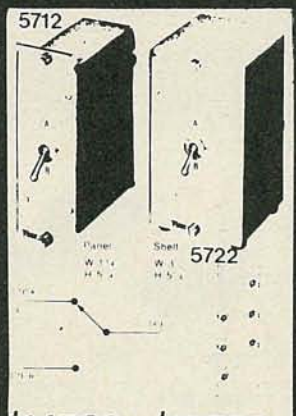

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GENERAL DESCRIPTION

The MSM5832 is a monolithic metal gate CMOS integrated circuit that functions as a real time clock calendar for use in bus-oriented microprocessor applications. The on chip 32.768 Hz crystal controlled oscillator time base is counted down to provide addressable 4 bit / 0 data of SECONDS, MINUTES, HOURS, DAY OF WEEK, DATE, MONTH and YEAR. Data at each is controlled by 4 bit address, chip select, read, write and hold inputs. Other functions include 12H, 24H format selection, leap year identification and manual +30 second correction. The MSM5832 normally operates from a 5 volt ±5% supply. Battery back up operation down to 2.2 volts allows continuation of time keeping when main power is off. One test input facilitates rapid testing of the time keeping operations. The MSM5832 is offered in an 18 lead dual in line plastic (RS suffix) package.

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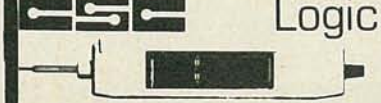

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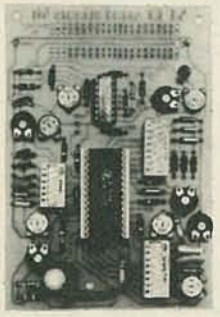

The SE-01 is a complete kit that contains all the parts to build a programmable sound effects generator. Designed around the new **Texas Instruments SN76477 Sound Chip**, the board provides banks of MINI DIP switches and pots to program the various combinations of the SLF Oscillator, VCO, Noise, One Shot, and Envelope Controls. A Quad Op Amp IC is used to implement an Adjustable Pulse Generator, Level Comparator and Multiplex Oscillator for even more versatility. The 3¼" x 5" PC Board features a prototype area to allow for user added circuitry. Easily programmed to duplicate **Explosions, Phasor Guns, Steam Trains,** or almost an infinite number of **other sounds.** The unit has a multiple of applications. The low price includes all parts, assembly manual, programming charts, and detailed 76477 chip specifications. It runs on a 9V battery (not included). On board 100MW amp will drive a small speaker directly, or the unit can be connected to your stereo with incredible results! (Speaker not included). **76477 is included.** Available separately for **$3.15** each.

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The AY3-8910 is a 40 pin LSI chip with three oscillators; three amplitude controls; programmable noise generator, three mixers, an envelope generator, and three D/A converters that are controlled by 8 BIT WORDS. No external pots or caps required. This chip hooked to an 8 bit microprocessor chip or Buss (8080, Z80, 6800 etc.) can be software controlled to produce almost any sound. It will play three note chords, make bangs, whistles, sirens, gunshots, explosions, bleets, whines, or grunts. In addition, it has provisions to control its own memory chips with two IO ports. The chip requires +5V @ 75ma and a standard TTL clock oscillator. A truly incredible circuit.

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- ★ "Next tune" feature allows sequential playing of all songs.
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74LS26	.49	74LS175	.75
74LS27	.26	74LS190	.75
74LS30	.28	74LS193	.95
74LS32	.32	74LS195	.95
74LS38	.32	74LS196	.85
74LS42	.65	74LS221	1.40
74LS48	.78	74LS240	1.65
74LS51	.25	74LS241	1.65
74LS54	.35	74LS243	1.45
74LS74	.38	74LS244	1.45
74LS75	.69	74LS245	2.25
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7400	$0.20	74125	$0.49	74LS12	$0.36	74LS196	$1.25	74S189	$3.35	74C907	$0.75	4089	$2.75	LM741CH	$0.55
7401	0.20	74126	0.49	74LS13	0.55	74LS197	1.25	74S194	2.15	74C908	1.19	4093	0.99	LM748CN	0.35
7402	0.20	74132	0.75	74LS14	1.10	74LS221	1.90	74S200	3.95	74C909	2.15	4099	2.10	LM1458N	0.58
7403	0.20	74141	0.79	74LS15	0.34	74LS240	2.25	74S206	4.55	74C910	6.00	4503	0.98	LM1496N	0.69
7404	0.20	74145	0.79	74LS20	0.34	74LS241	2.25	74S253	1.15	74C914	1.45	4507	0.99	LM1889N	2.25
7405	0.20	74147	1.70	74LS21	0.36	74LS244	2.25	74S257	1.45	74C918	1.49	4508	3.00	LM2111N	1.55
7406	0.20	74148	1.29	74LS22	0.36	74LS253	1.01	74S258	1.45	74C925	7.80	4510	1.15	MC1357P	1.55
7407	0.20	74150	1.10	74LS26	0.36	74LS257	0.86	74S280	2.75	74C926	7.80	4511	1.25	MC1455P1	0.35
7408	0.20	74151	0.59	74LS27	0.36	74LS258	0.86	74S287	3.90	74C927	7.80	4512	1.25	MC1456P1	0.95
7409	0.20	74152	0.59	74LS30	0.34	74LS260	0.38	74S289	4.35	74C928	7.80	4516	1.22	MC1456CV	0.95
7410	0.20	74153	0.59	74LS32	0.40	74LS266	0.49	74S387	5.70			4518	1.15	MC1458P1	0.58
7411	0.25	74154	1.15	74LS37	0.36	74LS279	0.73	93S00	2.00	**4xxx**		4519	0.62	MC1496L	0.69
7412	0.25	74155	0.69	74LS38	0.36	74LS283	0.99	93S05	2.30			4520	1.15	MC1709CP1	0.28
7413	0.20	74156	0.69	74LS40	0.34	74LS290	1.05	93S10	3.45	4000	$0.35	4527	1.67	MC1710CP	0.29
7414	0.25	74157	0.64	74LS42	0.82	74LS295	0.99	93S12	1.35	4001	0.35	4528	1.50	MC1711CP	0.39
7412	0.25	74158	0.64	74LS47	1.05	74LS365	0.66	93S13	1.95	4002	0.35	4539	1.35	MC1741CG	0.35
7413	0.39	74160	0.87	74LS48	1.05	74LS366	0.66	93S16	3.40	4006	1.19	4555	0.89	MC1748CP1	0.35
7414	0.70	74161	0.87	74LS49	1.05	74LS367	0.66	93S41	5.00	4007	0.35	4556	1.09	MC4741CP	1.25
7416	0.25	74162	0.87	74LS51	0.34	74LS368	0.66	93S42	1.50	4008	1.05	4582	1.09	MC7805CT	1.20
7417	0.25	74163	0.87	74LS54	0.34	74LS373	2.25	93S43	5.95	4009	0.49	4702	7.10	MC7806CT	1.20
7420	0.20	74164	0.87	74LS55	0.34	74LS374	2.25	93S46	1.55	4010	0.49	4703	8.25	MC7808CT	1.20
7423	0.25	74165	0.87	74LS73	0.45	74LS386	0.53	93S62	2.65	4011	0.35	4704	7.30	MC7812CT	1.20
7425	0.29	74166	1.22	74LS74	0.45	74LS390	1.89			4012	0.35	4705	9.25	MC7815CT	1.20
7426	0.29	74167	1.95	74LS76	0.52	74LS490	1.89	**74Cxx**		4013	0.48	4706	9.75	MC7824CT	1.20
7427	0.25	74170	1.58	74LS78	0.48	74LS670	2.45			4014	1.05	4720	6.95	MC78M12CT	0.77
7430	0.20	74173	1.24	74LS83	1.05			74C00	$0.34	4015	1.05	4723	1.50	MC75451P	0.50
7432	0.25	74174	0.89	74LS85	1.25	**74Sxx**		74C02	0.34	4016	0.53	4724	1.50	MC75492P	0.52
7437	0.25	74175	0.80	74LS86	0.49			74C04	0.35	4017	1.07	4725	3.95	MLM311P1	0.85
7438	0.40	74176	0.78	74LS90	0.71	74S00	$0.45	74C08	0.35	4018	1.07	40014	1.10	MLM324P	0.75
7439	0.29	74177	0.78	74LS92	0.71	74S01	0.45	74C10	0.34	4019	0.49	40085	1.69	MLM565CP	1.20
7440	0.20	74178	1.90	74LS93	0.71	74S02	0.45	74C14	0.90	4020	1.13	40098	0.69	N5558V	0.58
7441	0.88	74179	1.90	74LS95	0.99	74S03	0.45	74C20	0.34	4021	1.13	40106	0.90	N5596A	0.69
7442	0.59	74180	0.79	74LS107	0.44	74S04	0.46	74C30	0.34	4022	1.05	40160	1.17	N5733A	0.66
7443	0.75	74181	1.95	74LS109	0.44	74S05	0.46	74C32	0.34	4023	0.35	40161	1.17	NE501A	1.00
7444	0.75	74182	0.78	74LS112	0.49	74S08	0.48	74C42	1.00	4024	0.79	40162	1.17	NE526A	6.00
7445	0.75	74184	1.95	74LS113	0.49	74S09	0.48	74C48	1.27	4025	0.35	40163	1.17	NE531V	3.90
7446	0.69	74185	1.95	74LS114	0.49	74S10	0.45	74C73	0.71	4027	0.69	40174	1.15	NE550A	1.00
7447	0.65	74188	3.85	74LS123	0.98	74S11	0.48	74C74	0.71	4028	0.88	40175	1.15	NE555V	0.35
7448	0.79	74190	0.99	74LS125	0.62	74S15	0.48	74C76	0.71	4029	1.13	40192	1.37	NE556A	0.90
7450	0.20	74191	0.99	74LS126	0.62	74S20	0.45	74C83	1.45	4030	0.45	40193	1.37	NE560B	2.50
7451	0.20	74192	0.80	74LS132	0.91	74S21	0.48	74C85	1.45	4031	2.25	40194	1.17	NE565A	1.20
7453	0.20	74193	0.80	74LS136	0.48	74S22	0.46	74C86	0.49	4034	2.75	40195	1.17	NE566V	1.50
7454	0.20	74194	0.87	74LS138	0.93	74S30	0.45	74C89	3.95	4035	0.99			NE567V	0.98
7459	0.20	74195	0.87	74LS139	0.82	74S32	0.70	74C90	1.10	4040	1.20	**LINEAR**		SE540L	6.00
7460	0.20	74196	0.87	74LS151	0.75	74S40	0.45	74C93	1.10	4041	1.05			SN75451P	0.50
7470	0.29	74197	0.87	74LS152	0.75	74S50	0.45	74C95	1.30	4042	0.99	75451BTC	$0.50	SN75492N	0.52
7472	0.29	74198	1.45	74LS153	0.84	74S51	0.45	74C107	0.69	4043	0.89	75492PC	0.52	ULN2111A	1.55
7473	0.35	74199	1.45	74LS154	1.40	74S60	0.45	74C151	2.35	4044	0.89	DS7492N	0.52	uA311TC	0.85
7474	0.35	74251	1.09	74LS155	0.89	74S64	0.48	74C154	3.00	4046	1.79	LM311N	0.85	uA324PC	0.75
7475	0.49	74283	2.20	74LS156	0.89	74S65	0.48	74C157	2.05	4047	1.99	LM311V	0.85	uA555TC	0.35
7476	0.35	74290	0.99	74LS157	0.75	74S74	0.78	74C160	1.17	4048	0.95	LM324N	0.75	uA556PC	0.90
7480	0.40	74293	0.99	74LS158	0.75	74S76	0.78	74C161	1.17	4049	0.49	LM340T-5	1.20	uA709CV	0.28
7482	0.63	74298	0.92	74LS160	1.05	74S78	0.78	74C162	1.17	4050	0.55	LM340T-6	1.20	uA709TC	0.28
7483	0.69	74365	0.67	74LS161	1.05	74S86	0.78	74C163	1.17	4051	1.19	LM340T-8	1.20	uA710CA	0.29
7485	0.89	74366	0.67	74LS162	1.05	74S112	0.78	74C164	1.17	4052	1.19	LM340T-12	1.20	uA710TC	0.29
7486	0.40	74367	0.67	74LS163	1.05	74S113	0.78	74C165	1.17	4053	1.19	LM340T-15	1.20	uA711CA	0.39
7489	1.75	74368	0.67	74LS164	1.15	74S114	0.78	74C173	1.29	4060	1.49	LM340T-24	1.20	uA711PC	0.39
7490	0.43			74LS168	1.45	74S132	0.95	74C174	1.15	4066	0.78	LM342P-12	0.77	uA733PC	0.66
7491	0.59	**74LSxx**		74LS169	1.45	74S133	0.48	74C175	1.15	4068	0.39	LM348N	1.25	uA741CT	0.35
7492	0.43			74LS170	1.80	74S134	0.48	74C192	1.37	4069	0.35	LM350N	0.95	uA741HC	0.35
7493	0.43	74LS00	$0.34	74LS173	1.33	74S135	0.59	74C193	1.37	4070	0.49	LM382N	1.60	uA748CV	0.35
7494	0.65	74LS01	0.34	74LS174	1.20	74S138	0.97	74C195	1.17	4071	0.35	LM555CN	0.35	uA748TC	0.35
7495	0.65	74LS02	0.34	74LS175	0.89	74S139	1.90	74C200	7.50	4073	0.35	LM556CN	0.90	uA1458CTC	0.58
7496	0.65	74LS03	0.34	74LS181	2.50	74S140	0.57	74C221	1.89	4075	0.35	LM565CN	1.20	uA2136PC	1.55
7497	2.90	74LS04	0.38	74LS190	1.25	74S151	1.55	74C901	0.48	4076	1.29	LM566CN	1.50	uA7805UC	1.20
74107	0.34	74LS05	0.38	74LS191	1.25	74S153	2.60	74C902	0.48	4077	0.69	LM567CN	0.98	uA7806UC	1.20
74109	0.45	74LS08	0.36	74LS192	1.15	74S157	0.95	74C903	0.79	4078	0.45	LM709CN-8	0.28	uA7808UC	1.20
74121	0.34	74LS09	0.36	74LS193	1.15	74S158	1.55	74C904	0.79	4081	0.35	LM710CN	0.29	uA7812UC	1.20
74122	0.39	74LS10	0.34	74LS194	1.35	74S174	1.90	74C905	6.00	4085	0.39	LM711CN	0.39	uA7815UC	1.20
74123	0.58	74LS11	0.36	74LS195	1.35	74S175	1.75	74C906	0.75	4086	0.79	LM733CN	0.66	uA7824UC	1.20

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7401	0.15	7453	0.15	74154	0.53	74290	0.54	74LS55	0.15	74LS169	0.57			74S153	0.66
7402	0.15	7454	0.15	74155	0.38	74293	0.54	74LS73	0.21	74LS170	0.84			74S157	0.66
7403	0.15	7459	0.15	74156	0.38	74298	0.50	74LS74	0.21	74LS173	0.60	**74Sxx**		74S158	0.66
7404	0.17	7460	0.15	74157	0.38	74365	0.36	74LS75	0.30	74LS174	0.47			74S174	1.04
7405	0.17	7470	0.21	74158	0.38	74366	0.36	74LS76	0.23	74LS175	0.47	74S00	$0.23	74S175	0.95
7406	0.21	7472	0.21	74160	0.48	74367	0.36	74LS78	0.24	74LS181	1.36	74S01	0.23	74S189	1.83
7407	0.21	7473	0.21	74161	0.48	74368	0.36	74LS83	0.47	74LS190	0.58	74S02	0.23	74S194	1.17
7408	0.17	7474	0.21	74162	0.48			74LS85	0.54	74LS191	0.56	74S03	0.23	74S206	2.48
7409	0.17	7475	0.30	74163	0.48			74LS86	0.24	74LS192	0.56	74S04	0.24	74S240	1.29
7410	0.15	7476	0.21	74164	0.51	**74LSxx**		74LS90	0.33	74LS193	0.56	74S05	0.24	74S253	0.63
7411	0.17	7480	0.22	74165	0.51			74LS92	0.33	74LS194	0.74	74S08	0.24	74S257	0.78
7412	0.17	7482	0.34	74166	0.54	74LS00	$0.15	74LS93	0.33	74LS195	0.74	74S09	0.24	74S258	0.78
7413	0.24	7483	0.46	74167	1.06	74LS01	0.15	74LS95	0.54	74LS196	0.56	74S10	0.23	74S280	1.14
7414	0.41	7485	0.50	74170	0.84	74LS02	0.15	74LS107	0.22	74LS197	0.56	74S11	0.23	74S287	1.92
7416	0.20	7486	0.20	74173	0.58	74LS03	0.15	74LS109	0.22	74LS221	0.58	74S15	0.23	74S289	3.11
7417	0.24	7489	0.95	74174	0.46	74LS04	0.17	74LS112	0.24	74LS240	1.23	74S20	0.23	74S387	2.98
7414	0.41	7490	0.30	74175	0.45	74LS05	0.17	74LS113	0.24	74LS241	1.23	74S21	0.24	93S00	1.08
7416	0.20	7491	0.47	74176	0.47	74LS08	0.16	74LS114	0.24	74LS244	1.23	74S22	0.23	93S05	1.25
7417	0.20	7492	0.30	74177	0.47	74LS09	0.16	74LS122	0.41	74LS251	0.54	74S30	0.23	93S10	1.88
7420	0.15	7493	0.30	74178	1.04	74LS10	0.15	74LS123	0.47	74LS253	0.54	74S32	0.38	93S12	0.74
7421	0.17	7494	0.38	74179	1.04	74LS11	0.17	74LS125	0.33	74LS257	0.41	74S40	0.24	93S16	1.85
7423	0.18	7495	0.38	74180	0.48	74LS12	0.17	74LS126	0.33	74LS258	0.41	74S50	0.24	93S41	2.73
7425	0.18	7496	0.38	74181	1.02	74LS13	0.30	74LS132	0.47	74LS259	0.41	74S51	0.24	93S42	0.82
7426	0.18	7497	1.58	74182	0.53	74LS14	0.60	74LS133	0.26	74LS260	0.21	74S60	0.24	93S43	3.24
7427	0.18	74107	0.20	74184	1.06	74LS15	0.15	74LS136	0.26	74LS266	0.27	74S64	0.24	93S46	0.84
7430	0.15	74109	0.22	74185	1.06	74LS20	0.15	74LS138	0.45	74LS279	0.29	74S65	0.24	93S62	1.44
7432	0.18	74120	0.60	74188	2.10	74LS21	0.15	74LS139	0.45	74LS283	0.47	74S74	0.36		
7437	0.18	74121	0.26	74190	0.50	74LS22	0.15	74LS151	0.41	74LS290	0.58	74S76	0.36		
7438	0.18	74122	0.27	74191	0.50	74LS26	0.18	74LS152	0.41	74LS295	0.54	74S78	0.36	**74Cxx**	
7439	0.18	74123	0.38	74192	0.50	74LS27	0.16	74LS153	0.41	74LS298	0.54	74S86	0.36		
7440	0.15	74125	0.30	74193	0.50	74LS30	0.13	74LS154	0.72	74LS365	0.33	74S112	0.36	74C00	$0.20
7441	0.60	74126	0.30	74194	0.48	74LS32	0.17	74LS155	0.41	74LS366	0.33	74S113	0.36	74C02	0.20
7442	0.35	74132	0.39	74195	0.44	74LS37	0.18	74LS156	0.41	74LS367	0.33	74S114	0.36	74C04	0.20
7443	0.50	74141	0.53	74196	0.47	74LS38	0.18	74LS157	0.41	74LS368	0.33	74S132	0.52	74C08	0.20
7444	0.50	74145	0.45	74197	0.47	74LS40	0.15	74LS158	0.41	74LS373	0.96	74S133	0.23	74C10	0.20
7445	0.50	74147	0.89	74198	0.63	74LS42	0.42	74LS160	0.51	74LS374	0.96	74S134	0.24	74C14	0.46
7446	0.46	74148	0.62	74199	0.63	74LS47	0.60	74LS161	0.51	74LS386	0.28	74S135	0.42	74C20	0.20
7447	0.46	74150	0.54	74221	0.50	74LS48	0.51	74LS162	0.51	74LS390	0.93	74S138	0.49	74C30	0.20
7448	0.46	74151	0.38	74251	0.57	74LS49	0.54	74LS163	0.51	74LS393	0.93	74S139	0.98	74C32	0.20
7450	0.15	74152	0.38	74279	0.36	74LS51	0.15	74LS164	0.51	74LS490	1.02	74S140	0.26	74C42	0.72

74C48	$0.96	74C903	$0.34	4016	$0.28	4053	$0.54	4528	$0.71
74C73	0.46	74C904	0.34	4017	0.54	4060	0.59	4539	0.74
74C74	0.46	74C905	5.10	4018	0.54	4066	0.27	4555	0.48
74C76	0.44	74C906	0.34	4019	0.27	4068	0.21	4556	0.59
74C83	0.89	74C907	0.34	4020	0.63	4069	0.17	4582	0.59
74C85	0.89	74C908	0.76	4021	0.56	4070	0.23	4584	0.43
74C86	0.23	74C909	1.38	4022	0.56	4071	0.17	4702	3.87
74C89	2.42	74C910	3.27	4023	0.17	4072	0.17	4703	4.50
74C90	0.71	74C914	0.78	4024	0.47	4073	0.17	4704	3.98
74C93	0.71	74C918	0.89	4025	0.17	4075	0.17	4705	5.04
74C95	0.82	74C925	3.90	4026	0.99	4076	0.53	4706	5.32
74C107	0.44	74C926	3.90	4027	0.36	4077	0.38	4720	3.78
74C151	1.37	74C927	3.90	4028	0.50	4078	0.24	4723	0.78
74C154	2.04	74C928	3.90	4029	0.58	4081	0.17	4724	0.78
74C157	1.37			4030	0.23	4085	0.42	4725	2.15
74C160	0.71			4031	1.12	4086	0.42	40014	0.46
74C161	0.71	**4xxx**		4034	1.30	4089	1.07	40085	0.89
74C162	0.71			4035	0.71	4093	0.36	40098	0.38
74C163	0.71	4000	$0.20	4040	0.63	4099	0.80	40106	0.46
74C164	0.71	4001	0.17	4041	0.54	4502	0.23	40160	0.71
74C165	0.77	4002	0.17	4042	0.54	4503	0.36	40161	0.71
74C173	0.65	4006	0.71	4043	0.54	4507	0.42	40162	0.71
74C174	0.65	4007	0.20	4044	0.54	4508	1.64	40163	0.71
74C175	0.65	4008	0.65	4045	0.89	4510	0.59	40174	0.65
74C192	0.72	4009	0.27	4046	0.63	4511	0.65	40175	0.65
74C193	0.72	4010	0.27	4047	0.64	4512	0.68	40192	0.72
74C195	0.71	4011	0.17	4048	0.28	4516	0.59	40193	0.72
74C200	4.08	4012	0.17	4049	0.28	4518	0.59	40194	0.71
74C221	0.96	4013	0.30	4050	0.28	4519	0.30	40195	0.71
74C901	0.34	4014	0.54	4051	0.54	4520	0.59		
74C902	0.34	4015	0.54	4052	0.54	4527	0.71		

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FREQ (MHz)	CASE	P/N	PRICE	FREQ (MHz)	CASE	P/N	PRICE	FREQ (MHz)	CASE	P/N	PRICE
1.00	HC33	CY1A	$9.50	4.9152	HC18	CY6A	$6.00	16.00	HC18	CY15A	$4.75
1.8432	HC33	CD1A	9.50	5.00	HC18	CY7A	6.00	18.00	HC18	CY18A	4.75
2.00	HC33	CY2A	8.25	5.068	HC18	CY8B	6.00	18.432	HC18	CY19B	4.75
2.4576	HC33	CY2B	8.25	5.7143	HC18	CB5C	6.00	19.6608	HC18	CY20A	4.75
3.2768	HC33	CY3B	8.00	6.00	HC18	CY8B	6.00	20.00	HC18	CY22A	5.25
3.579	HC33	CY3D	8.00	8.144	HC18	CY8C	6.00	22.656	HC18	CY23B	5.25
4.00	HC18	CY3A	8.00	8.00	HC18	CY8G	6.00	27.00	HC18	CY27A	8.15
4.434	HC18	CY4C	6.00	10.00	HC18	CY12A	4.75	32.00	HC18	CY32A	8.15
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74LS10N	.24
74LS11N	.31
74LS20N	.24
74LS22N	.34
74LS26N	.39
74LS27N	.29
74LS32N	.34
74LS37N	.36
74LS40N	.34
74LS42N	.45
74LS73N	.38
74LS74N	.54
74LS86N	.45
74LS90N	.44
74LS93N	.42
74LS109N	.52
74LS112N	.42
74LS123N	.79
74LS125N	.89
74LS126N	.54
74LS132N	.59
74LS136N	.48
74LS138N	.66
74LS139N	.66
74LS145N	1.20
74LS151N	.44
74LS152N	.75
74LS153N	.42
74LS160N	.95
74LS161N	.80
74LS162N	.85
74LS163N	.85
74LS164N	.62
74LS170N	2.65
74LS174N	.49
74LS175N	.49
74LS181N	2.30
74LS190N	1.20
74LS191N	.89
74LS193N	.89
74LS194N	.85
74LS195N	.65
74LS221N	.85
74LS240N	.95
74LS241N	.90
74LS243N	.99
74LS244N	.95
74LS245N	2.20
74LS251N	2.20
74LS253N	.59
74LS257N	.80
74LS258N	.65
74LS260N	.65
74LS266N	.48
74LS273N	1.35
74LS299N	2.60
74LS365N	.75
74LS366N	.79
74LS367N	.70
74LS373N	1.45
74LS374N	1.40
74LS377N	1.40
74LS381N	2.90
74LS490N	1.80

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LM320-18K	2.20	78L08ACP	.60	79L18CP	1.00
LM320-24K	2.20	78L08CP	.55	79L24ACP	1.50
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ICM7038-C1PA	3.00	ICM7216-B1P1	26.65	ICM7240-1JE	4.90
ICM7045	14.95	ICM7216-C1J1	26.65	ICM7241-1PA	3.40
ICL71C03-ACP1	13.80	ICM7216-D1P1	21.40	ICM7242-1JA	2.05
ICL7106-CPL	15.50	ICM7217-A1P1	11.25	ICM7250-1JE	6.00
ICL7107-CPL	15.00	ICM7217-B1J1	12.40	ICM7260-1JE	5.25
ICL7116-CPL	18.70	ICM7217-C1P1	10.35	ICM7270-1PL	5.85
ICL7117-CPL	17.70	ICM7217-1J1	12.40	ICM7555-1PA	1.20
ICM7201-1DR	2.25	ICM7218-C1J1	10.75	ICM7556-1PD	2.25
ICM7205-1PG	13.00	ICM7223-1PL	7.90	ICL7660-CPA	3.00
ICM7206-CJPE	5.15	ICM7224-1PL	11.25	ICL8038-CCJD	4.70
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4.0 MHz

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P6507A	10.70
P6512	10.70
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P6514	9.70
P6514A	10.70
P6515	9.70
P6515A	10.70
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CA3079	2.23	MC1350P	1.15	MC1469G	4.24
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MBD501	1.57	MC1357P	1.55	MC1489L	1.48
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MC664P	3.20	MC1364P	2.01	MC1494L	6.04
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MC678P	2.05	MC1403AU	11.07	MC1809P	1.36
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				MC4316L	16.72
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				MC8311P	2.50
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				MC10104P	.92
				MC10109L	1.24
				MC10116L	1.24
				MC10116P	.92
				MC10123L	2.38
				MC10124L	3.01
				MC10125L	2.50
				MC10131P	3.04
				MC10137L	25.38
				MC10159P	4.14
				MC10189L	3.27
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				MC10198P	22.51
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				MC14411P	17.13
				MC14412VP	16.53
				MC14436VP	11.53
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				MC14458P	13.73
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				MC14490VP	4.24
				MC14495P	3.96
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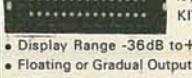

70 pcs.
KIT $31.50

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- Floating or Gradual Output Indicating
- Kit includes transistors, leds, capacitors, resistors, PC Board, and silk screened metal front panel

SYM-1

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